Chapter 1

OVERVIEW OF FORECASTING TECHNIQUES AND IMPORTANCE OF FORECASTING

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1. INTRODUCTION

A time series is a measurement order especially modified at a consistent-consistent obstruction in time. Samples take part in a grouping of scopes in each field from financial to infrastructure, and the approach to time series analysis is an critical topic in statistics. In other terms, a time series is a list of the sequential and frequently separated factors that arise in time (Bowerman and O'Connell, 1987; Makridakis et al., 1998).

Assessment of the time series encourages simulation sensitivity that needs only data on the formed variables, thereby saving the analyst from the complexity of evaluating the impact variables and offering a basis for interconnecting such variables. Univariate Box-Jenkins Analysis (Box and Jenkins, 1976) – Methodology for modeling and forecasting has usually been implemented with far further application (Box et al. , 1994; Makridakis et al., 1998; Albayrak, 2010; Green, 2011).

Work schedules staff and logistics, processing payments for supplies and determining whether to launch new goods, increase processing capability or build new structures are only a handful of an organization's regular functions. Managers ought to understand what the potential market climate would be when taking such choices. Although we never say for sure what's going to happen in the future, there are methods that will help us forecast the particular facets of the future and appreciate the level of ambiguity there is. The better their capacity to foresee the future, the less probable their decisions would be. Forecasting offers the administrators and decision-makers with logical hypotheses. One of the main measures of how well a model works is how effectively it forecasts. The method has to have lags in either the coefficients or standard errors to generate accurate predictions (Makridakis et al., 1998; Green, 2011; Sanders and Reid, 2012).

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There are various analytical difficulties characterizing the forecasting processes. For example, airlines in the aviation industry that plan traffic growth forecasts focused on assuming current regulations and competitive conditions continue. For both passenger and freight traffic, segmented on a single road, road categories, or geographic areas, the forecast could be. Airlines have to estimate their own market share of traffic from such predictions, mostly under the premise that the operating environment would stay unchanged. This is never the case however, at least not in the long term. Increases in economic growth, foreign exchange levels, tourist habits etc. In addition, demand is prone to improvements in the standard of operation, including rates and size of aircraft, speeds, and schedules. Furthermore, predicted adjustments in these parameters must be taken into consideration when planning traffic forecasts. Traffic planning is typically the greatest problem for modern roads, on which no past traffic records remain. These forecasts can need specific prediction techniques than commonly used ones (Doganis, 2010; Solvolla et al., 2016; Solvolla et al., 2020).

Forecasting is the art and science of predicting potential things. Because economies and organisations have grown broader and increasingly diverse, as developments have arisen increasingly quickly, the time period for decision-making has declined, and the effects of bad decision-making have increased. As a consequence, the forecasting mechanism must become more structured, reliable and efficient The object of creating forecasts (though obtained) is to use these as inputs into a decision-taking method, either directly or indirectly (Martinich, 1997; Hanke and Wichern, 2005).

This subject is involved by addressing briefly the significance and function of forecasting in production management systems. Then the forms of model forecasts are highlighted. This issue does not have anything about qualitative forecasting but It is based on quantitative forecasting instead. Of the other mathematical forecasting approaches, it is involved the moving averages, linear smoothing, and regression techniques.

Many statistical models are better adapted for short-term forecasting, whereas other approaches are ideally suited for long-term forecasting. Certain strategies are better adapted to predicting traffic on current roads or markets, whereas other approaches are more suitable when planning traffic forecasts for new routes. Many approaches are more fitting for the study of the expected consequences of small transportation system improvements, whereas other techniques are more suited for large adjustments (Makridakis et al., 1998). In addition, the prediction approaches differ due to data necessity, data processing costs, the period needed for planning the forecast and the expense of producing a prediction (Hanke and Wichern, 2005).

Assessments have already shown that public transport expectations are sometimes unreliable (Flyvbjerg et al., 2005; Van Wee, 2007; Odeck, 2013; Nicolaisen and Driscoll, 2014; Odeck and Welde, 2017), and that the causes can involve mistakes in the data content, choosing of forecasting system and/or skill of the predictor, as well as unexpected events mostly during forecasting era. Analyzing the time series and regression equations also have fairly little potential application as traffic predictions have to be planned for new roads. One plausible solution in this situation is to use a concept of gravity, which is a subcategory of causal models (Doganis, 2010; Nicolaisen and Driscoll, 2014).

2. THE PURPOSE AND SIGNIFICANCE OF FORECASTING IN PRODUCTION AND STRATEGIC PLANNING SYSTEMS

In manufacturing, a significant need for forecasting is the commodity demand field Market forecasts incorporate several aspects of an enterprise from preparing equipment, staff, development, and procurement of materials to promotion and delivery (see Figure 2). Inaccurate demand predictions may contribute to over- or underfunding of activities, inventory shortages, surplus inventories and late delivery. In comparison, specific demand forecasts may contribute to prompt product launch. Facilities completion, including personnel including product changes (Makridakis and Wheelwright, 1989; Makridakis et al., 1998; Martinich, 1997; Sanders and Reid, 2012).

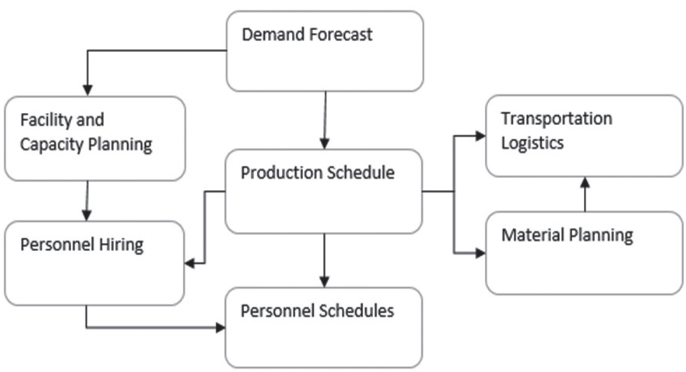

Figure 1. The Position of Demand Predictions In Business (Martinich, 1997)

Many output fields involving forecasts involve inventory needs (buying and acquisition), labor planning acquisitions of machinery. Site capacity preparation and repair specifications (Makridakis and Wheelwright, 1989; Martinich, 1997; Makridakis et al., 1998).

3. FORECASTING METHODS

Several techniques were used to render forecasts about potential occurrences. Based on the particular situations, the degree to which one solution is superior than another. It is necessary to address the following questions before selecting a general prediction method (Martinich, 1997; Makridakis et al., 1998; Makridakis and Wheelwright, 1989);

1. How are the predictions intended? Who are they going to be for?
2. Which time is taken to have support for the projections?
3. What unique (variable) agency could be predicted?
4. What knowledge or evidence is accessible about the expected entity?
5. What are the variables that impact or contribute to the company?

1. Short-term forecasts: They aim forward no more than three months. Such predictions are used for operational decision taking, such as task ordering and output management, equipment allocations, buying workers scheduling, and procurement administration.

2. In-between predictions. These have a three month to two year time span. These are more widely used for quantitative preparation of output, including decisions that change short-term efficiency, such as outsourcing and overtime.

3. Long-term forecasts: Typically they have a two or five year time period. Its most popular application is to schedule the launch of new goods and big capital costs

Predictive measures (Sanders and Reid, 2012; Url, 4):

The forecasting method comprises five simple steps:

1- Determine the predicted goal and when it would be appropriate. It will include proof of the degree of specificity involved in the prediction, the amount of capital that will be mobilized and the degree of precision needed.
2- Set a time period that the prediction will match, keeping in mind that accuracy reduces as the time horizon rises.
3- Use a realistic outlook,
4- Collect and evaluate the related details, and then plan a prediction. Describe any observations created when planning and utilizing the forecast that will have relation.
5- Observe the prediction to decide if this works satisfactorily. If not, re - evaluate the methodology, conclusions, data validity etc., adjust as required, and arrange a modified forecast.

The significant feature of the time period for the techniques of forecasting is amount of cycles needed for a prediction. Several methods are ideal for projecting only one or two cycles in time, and some may be used over many times (Makridakis and Wheelwright, 1989; Makridakis et al., 1998; Hanke and Wichern, 2005).

Methods of prevision are often known as;

- Methodological methods to forecasting -qualitative forecasting methods
- The techniques of predictive forecasting- quantitative forecasting methods

Four main forecasting concepts are (Evans, 1993; Martinich, 1997, Hanke and Wichern, 2005):

1. Forecasts contain probable errors: Forecasts are exceedingly difficult to match the real values perfectly. Forecasting tends to develop risks but does not eradicate them entirely.
2. Forecasting programs would involve calculating predictive errors: because each prediction entails a certain degree of error, the forecaster wants to know the predictive accuracy.
3. Community forecasts are more reliable than person forecasts: specific forecasts for a product class (aggregate) would be better than specific forecasts for individual pieces of the same product category.
4. Short-term forecasts are more reliable than long-term forecasts: the short-term impact impacting the institution to be predicted would be more robust and long-term forecasts would be the same.

Qualitative methods of forecasting depend on one or more entities to produce predictions by utilizing statistical models alone. Qualitative prognosis integrates the expertise, instincts, beliefs , and personal preferences of the forecaster into the prediction. Such are called forms of arbitrary forecasting, since there is no means of knowing precisely what knowledge the forecaster is utilizing and how. These predictions are for the forecaster exclusive and can not be duplicated by anyone. Generally speaking we will start utilizing methodological statistical methods when (Makridakis and Wheelwright, 1989; Makridakis et al., 1998; Hanke and Wichern, 2005):

- There are little, or no, historical records.
- In the forecast horizon the related climate is expected to be unpredictable.

The projection includes a long period span, maybe about three or five years. Many of the more widely employed numerical prognostic approaches are as follows ;

(Makridakis and Wheelwright, 1989; Makridakis et al., 1998; Evans,1993; Martinich, 1997;Makridakis et al., 1998; Hanke and Wichern, 2005):

1. Group-Community averaging: This approach entails clearly taking and combining individual forecasts

2. Group-Community Consensus: Representatives work as a party, use this form. Every participant offers a prediction, and then describes how he got there. Afterwards the participants will analyze the predictions and help material. The end aim is to settle on one prediction, called the expected consensus.
3. Delphi Method: Through this approach the decision-maker may order a prediction from multiple experts. Arguments endorsing, and details used to arrive at the prediction. This material is collected and analyzed, and then communicated in writing to every specialist without revealing the experts' identities. New prognoses and supporting claims are sought utilizing this material. This cycle is replicated before you receive one or more consensus forecasts.
4. Consumer-Market Research: Market study is the comprehensive review of data obtained by customer polls, consumer centers, and business experiments; Market polls include interviewing a group of customers about how to react to shifts in the determinants of a product 's market and relevant goods. Market clinics are experimental tests in which subjects collect a amount of money and are challenged to invest it in a virtual shop to see how they respond to adjustments in the request for a product's predictors. Eventually, the forecaster adjusts the determinants of a product 's demand in a given real-world shop or markets in industry tests, and explores customer reactions to shifts.

4. QUANTITATIVE FORECASTING METHODS

Quantitative methods of forecasting utilize predictive methods to depict interactions between related variables on the basis of historical data and/or established connections. These techniques are often referred to as analytical methods of forecasting, since regardless of the consumer, the fundamental principles of the forecasting model and the data used can be described accurately. And, if two people use the same model and info, they will get the same results (Makridakis and Wheelwright, 1989; Evans, 1993; Makridakis et al., 1998; Hanke and Wichern, 2005). The first form of, and probably the most popular, quantitative forecasting model is the time-series model. Time series simulations predict the dependent variable's predicted values using only prior values of the variable. Models of the time series are generally useful for short to intermediate prediction. The following five aspects (see Figure 2) are the most important in time series models;

1. Sturdy (or Horizontal) part,
2. A aspect of the Trend,
3. An aspect which is Seasonal.
4. An aspect of Cycle,
5. A Random aspect

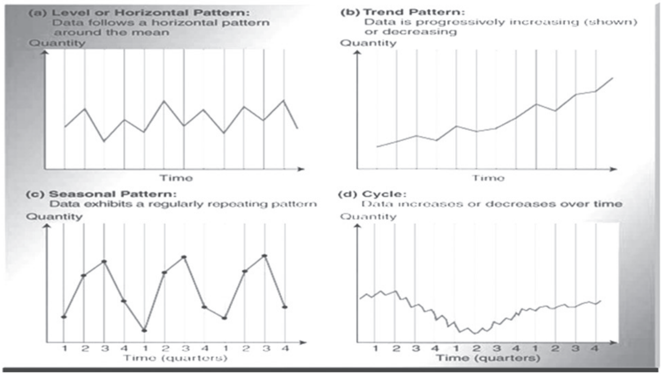

Figure 2. Time-Series Aspects-Components (Modified from Makridakis and Wheelwright, 1989; Hanke and Wichern, 2005)

The second form of approach of quantitative forecasting is explanatory. Certain terms used for this category of models include research model and relational models. Causal models presume the value of the (dependent) variable is linked to the values of certain (independent) variables which are timely knowable. Under these methods some shift in inputs would inevitably influence the performance of the device, given the interaction is constant. The first function of forecasting is to identify the relation by analyzing the device performance and compared to the corresponding inputs (Makridakis and Wheelwright, 1989; Makridakis et al., 1998; Hanke and Wichern, 2005).

4.1. Smoothing Techniques

Two specializations of smoothing strategies are the average methods and linear smoothing methods. Averaging strategies are compatible with the traditional average description, where exponential smoothing techniques apply differential proportions to past data. The simple principle underlying in exponential smoothing is that the predicted values to be estimated have some underlying pattern, and that the historical observations of each variable reflect both the underlying structure and random fluctuations. For a thorough overview of such methods (Makridakis and Wheelwright, 1989; Evans, 1993; Makridakis et al., 1998; Hanke and Wichern, 2005):

$$F_{T+1} = \left(\sum_{t=1}^{T} y_t \right) \Big/ T$$

$$F_{t+k} = I_t + kS_t$$

$$I_t = F_t + \alpha \left[y_t - F_t \right]$$

$$S_t = S_{t-1} + \alpha\beta e_t$$

$$ME = \sum_{i=1}^{K}(y_i - F_i) \Big/ K$$

$$MAPE = 100 \times \left[\sum_{i=1}^{K} |y_i - F_i| \right] \div y_i \Big/ K$$

Where F_{T+1} = forecast for (T +1)th period

y_t = actual value at t th period.

T = number of periods included in average

4.1.1. Moving Average

$$F_{T+1} = \frac{1}{N} \sum_{i=T-N+1}^{T} X_i$$

$$F_T = \frac{X_{T-1} + X_{T-2} + \ldots + X_{T-N}}{N} \Rightarrow F_{T+1} = \frac{X_T}{N} - \frac{X_{T-N}}{N} + F_T$$

Where, N=moving period

4.1.2. Simple Moving Average

$$F_{T+1} = SMA(N) = \left[y_T + y_{T-1} + \ldots + y_{T-N+1} \right] / N$$

The expression above is the average of the N most recent data points and is called the N-period simple moving average (SMA (N)).

4.1.3. Weighted Moving Average

The SMA approach gives the same weight to each of the N most recent data points. We define N period weighted moving average as (WMA(N)).

$$F_{T+1} = WMA(N) = w_1 y_T + w_2 y_{T-1} + \ldots + w_N y_{T-N+1}$$

Weights are assigned to only the N most recent data points; the weight w1 is assigned to the most recent data point, w2 to the second most recent and so on.

The weight must sum to 1 and satisfy the condition

W1> w2> … >WN> 0

That is, weights get smaller for the older data.

4.1.4. Simple Exponential Smoothing

Exponential Smoothing applies the most weight to the most recent observed values and decreasing weights to the older values. Simple exponential smoothing uses an iterative equation to revise its forecast for each period based on the accuracy of its most recent forecast.

$$F_{t+1} = \alpha X_1 + (1-\alpha)F_t \quad \text{or} \quad F_{t+1} = F_1 + \alpha(X_t - F_t)$$

Where $0 \le \alpha \le 1$

4.1.5. Holt's Double Exponential Smoothing

An extension of simple exponential smoothing which is called double exponential smoothing or pattern-adjusted moving average is a common approach used for linear pattern processes. In our analysis we will be utilizing the double exponential smoothing from Holt. Holt's approach utilizes two constants of smoothing: α to smooth the intercept, and β to smooth the slope. The optimal values of a and B are determined by testing out various value combinations and selecting the set of values the decrease the mean squared error or absolute mean. Where,

$$F_{t+k} = I_t + kS_t \qquad \text{(forecast)}$$

$$I_t = F_t + \alpha\left[y_t - F_t\right] \qquad \text{(smoothing of data)}$$

$$S_t = S_{t-1} + \alpha\beta e_t \qquad \text{(smoothing of trend)}$$

4.1.6. Winter's Exponential Smoothing

So long as the distribution is non-seasonal, the approaches tested so far will accommodate stationary or non-stationary results. This system is, nevertheless, capable of managing seasonal details, besides having a pattern. The approach used by Winter is based on three smoothing equations-one for stationarity, one for pattern and one for seasonal variation.

$$S_t = \alpha \frac{X_t}{I_{t-L}}(1-\alpha)\left(S_{t-1} + T_{t-1}\right) = S_{t-1} + T_{t-1} + \frac{\alpha e_t}{I_{t-1}} \qquad \text{(overall smoothing)}$$

$$T_t = \gamma\left(S_t - S_{t-1}\right) + \left(1-\gamma\right)T_{t-1} = T_{t-1} + \frac{\alpha\beta e_t}{I_{t-1}} \qquad \text{(trend smoothing)}$$

$$I_t = \beta \frac{X_t}{S_t} + \left(1-\beta\right)I_{t-L} = I_{t-L} + \frac{\gamma\left(1-\alpha\right)e_t}{S_t} \qquad \text{(seasonal smoothing)}$$

$$F_{t+m} = (S_t + T_{tm})I_{t-L+m} \qquad \text{(forecasting)}$$

Where L= length of seasonality

4.2. Simple Linear Regression

A prediction would be represented as a function of a certain number of factors or variables in these methods which affect its outcome. These predictions-forecasts don't actually need to rely on time. Regression models in the data set can withstand the case for trend pattern. The guiding principle of utilizing simple regression is the presumption that there is a fundamental relationship between two variables and that it can be expressed by any functional structure. Regression analysis is a statistical study described on a mathematical model and structured to analyze and forecast the relation between different or perhaps more financial factors using a Different multiple regressions (Aşıkgil, 2006; Biçkici, 2007). Regression is more commonly defined as the method of analyzing the relationships between variables and their connections. Regression analysis examines the degree to which one or more variables influence one or more measures in the other. If the variables are connected, the next task is to decide the magnitude of the relationship and its operational type. In several other terms, the regression analysis predicts possible relationship between dependent variable focused on the values of the independent variables in a framework developed by forecasting statistical values (Bakın, 2007).

$Y = a + bX$ From forecasting point of view the equation is rewritten as;

$F_t = a + b_t$ where a is the basis component and bt is the trend component.

5. MEASURING THE ACCURACY OF QUANTITATIVE TO FORECASTING MODELS

In order to assess alternative models, the assumptions should be validated and the forecasting for each model should be comparable. In this reason, the following five parameters should be considered. Versions with error values that are close to zero are best for the defined data set than other versions. Note that one method is well complied with one criterion and bad complies with another. The forecasting authority will analyze the findings and choose the appropriate one for its data Collection (Makridakis and Wheelwright, 1989; Makridakis et al., 1998; Hanke and Wichern, 2005; Green, 2011).

The discrepancy between the real value and the expected value is a residual value.

$e_i = Y_i - F_i$

e_i= the forecast error in time period i

Y_i= the actual value in time period i

F_i= the forecast value for time period i

K= number of samples included for error calculation

$$ME = \sum_{i=1}^{K} (y_i - F_i) \Big/ K \quad \text{(Mean Error)}$$

Forecasting Methods applied to determine forecasting methods are the mean absolute deviation (MAD), the mean squared error (MSE) and the mean absolute percentage error (MAPE).

(i) MAPE OR Mean Absolute Percentage Error, evaluates the appropriate time series precision. It illustrates specificity, for example, a fraction. (Equation: Eq.)

$$MAPE = 100 \times \left[\sum_{i=1}^{K} \left| y_i - F_i \right| \right] \div y_i \Big/ K \qquad \text{Eq.(1)}$$

(ii) MAD, which presents for Mean Absolute Deviation; The precision of the time series values is calculated. The exactness of this statement is similar to that of the evidence given by the amount of errors.

$$MAD = \sum_{i=1}^{K} \left| y_i - F_i \right| \Big/ K \qquad \text{Eq.(2)}$$

(iii) MSE considers for Mean Squared Deviation-Error, MSE is always calculated the same divisor, n, according to the model, especially as explained taht comparing MSE values across time series models. MSE is much more sensitive portion-scope of a general-common large predict error-residual than MAE.

$$MSE = \sum_{i=1}^{K} \left(y_i - F_i \right)^2 \Big/ K \qquad \text{Eq.(3)}$$

The critical difference among MSE and MAE is that the MSE calculation is far more affected by serious fitting errors than by minor errors (since the errors are squared for MSD measurement) (Makridakis and Wheelwright, 1989; Makridakis et al.,1998; Hanke and Wichern, 2005; Green, 2011).

6. CONCLUSION AND SUMMARY

Economic forecasts guide judgments on military activities, such as selection of strategic goals, method improvements and major product acquisitions. Forecast assessments function as the foundation for logistical planning; the creation of schedules for employees. Nearly all projects strategy decisions are focused on a forward-looking outlook. Economic forecasts are essential to the control of all operating areas (organizational functional scope) of the company. These are marketing uses forecasts to estimate demand and potential revenue, finance predicts asset values, capital spending requirements, financial Results, data networks have data sets and knowledge exchange capabilities and human services foreshadow potential job demands.

To sum up, time series models are focused on the premise that the time series of data includes all of the details required. Causal models presume the prediction component is linked to certain climate variables. There are four simple data patterns: level or horizontal, wave, seasonality, and period. Furthermore, there are typically random differences in results. Any prediction models used to predict a time series stage are: naïve, simple estimate, simple average acceleration, weighted average acceleration, and exponential smoothing. Separate methods are used to predict seasonality and patterns. Three simple statistical concepts are: predictions are never flawless, are more reliable for classes than individual objects, and are more effective than longer time horizons in the short term.

Five steps are involved in the forecasting process: deciding what to forecast, evaluating and analyzing appropriate data, selecting and testing model, generating predictions and monitoring accuracy.

The techniques of forecasting can be divided into two groups: qualitative and quantitative. Qualitative approaches are focused on the forecaster's professional judgment and statistical analysis is focused on quantitative techniques.

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