International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 02, 2020
ISSN: 1475-7192

A Survey On Forecasting of GDP: An Issue of Relevance in Macro-economics

[1]Anuradha Banerjee

Abstract: *The present paper is a review of various models concerned with forecasting of GDP, both in the short and long run. Certain parameters that influence growth of GDP, are identified and analyzed from quarterly, monthly or yearly data sets. Regression has been heavily used in this context, be it linear or auto-regressive integrated moving average (ARIMA) model. Small bridge equations play an important role to bridge the gap between monthly and quarterly data sets, and between quarterly and yearly data sets, in literature of forecasting and nowcasting GDP in economics.*

Keywords – *ARIMA, Economy, GDP, models, policy.*

I. Introduction

Central banks of different countries use various models for computing early estimates of current quarter GDP and short term forecasts of next quarter GDP. This macro-economic prediction helps government in refining policy decisions including expenditure, money supply, trade balance etc. Long term borrowing especially in the international market depends a lot on these decisions. Increase in government expenditure or supply of money in the market, are two important steps which are taken to tackle recession. According to Girardi et. Al., [1], certain macro-economic indicators have become standard in the sense that they are accepted across multiple countries; however, there may be certain differences between leading GDP predictor parameters of various countries. So, it is very difficult to come up with questionnaires that will be equally applicable for multiple countries. Among such questionnaires and surveys, three important examples are Purchasing Manager Index (PMI) provided by Markit, indicators from the European Commissions Joint Harmonized EU Programme of Business and Consumer Surveys (BCS) and Composite Leading Indicator (CLI) of OECD. BCS is concerned only about certain European countries while set of questions covered by PMI or issues investigated by it, embed more than 30 developed and developing countries [2].

Apart from advantages and disadvantages of the model used to estimate future GDP, publication lag also plays an important role. Application has to take place in real time although required data might be a bit outdated, thus enforcing us to comprise with accuracy of prediction. The error may prove to be significant from both statistics and econometrics point of view. To cater this problem, some evaluation methodologies have evolved that ignore newly released snapshot or most recent version of data released earlier. In literature of macroeconomics, bridge

[1] Dept. of Information Systems, Indian Institute of Management, Shillong, Meghalaya, India
Received: 02 Dec 2019 | Revised: 24 Jan 2020 | Accepted: 16 Feb 2020

equations play an important role. As the name suggests, they serve as a link between monthly and quarterly released data about GDP growth [3, 6, 7-10]. Traditional bridge equations can handle only a few variables. Therefore, to extract maximum benefit out of these equations, they are averaged using various regression techniques; often they perform "bridging with factors", i.e. incorporating as many indicators as possible, within the same level. Kalman filters are often applied to take care of missing data.

The article is organized as follows. Section 2 is dedicated to the study of forecasting GDP growth in India, while section 3 is concerned about the same in rest of the world, especially in various countries of Europe and China. Section 4 concludes the paper.

II. Forecasting GDP From India's Perspective

Article [11] was published in 2012. It came out with an intention to predict India's GDP values and rate of growth in every year from 2012 to 2021. GDP at timestamp t is modeled as a function $f(\alpha, \phi_p, \theta_q)$ where α is a constant, ϕ_p specifies coefficient of impact of GDP at time (t-p) over GDP at time t; θ_q is random shock at time q while $\in_t$ denotes the error term at t. These are certain factors of GDP which the authors want to study and investigate using ARIMA model. For each of them, a null and alternate hypothesis are designed to analyze their impact on current GDP. Null hypothesis assigns zero value to the parameter, that is, mathematically expresses the situation where concerned parameter has no influence on the current GDP. On the other hand, alternate hypothesis models non-zero impact of the same on GDP at current time t. The authors claim to have successfully uncovered hidden pattern in the data on GDP of India from 2012 to 2021. Also it shows that current GDP is functionally related to one period lag of GDP itself and same lag with respect to error term. Similar analysis is performed for growth rate also.

In [12], the author S. Mahendra Dev has emphasized on the following things:

i) Differences between household sector and hardcore industry.

ii) Expected growth of GDP vs. hard realities (this depends on accuracy of the model under consideration).

iii) GDP at market prices vs GDP at factor prices.

iv) Impact of GDP growth on agriculture especially.

Consumption is a very important factor for predicting GDP, for which two estimates are parallel taken by Indian Statistical System. They are NSS and NAS. Full form of NSS is National Simple Survey and full form of NAS is National Accounts Statistics. The value estimated by NSS signifies entire consumption of all nation whereas for NAS, it is the difference between estimates of production and projected use of the same in market as business capital. Generally these two predicted consumptions are not same but what is more disturbing is that the difference of these two values are increasing continuously.

Major changes in GDP takes place due to changes in data of corporate money and the same of government, informal sector and trade income. Particularly as far as agricultural sector is concerned, both real and

nominal growths are noticed. Real growth denotes vibrant progress whereas nominal growth indicates that policy changes have started working.

Reference [13] says that India significantly changed its methodologies to estimate GDP growth after 2011, which led to substantial over-estimation of it, resulting in great loss of reputation in the international market. Policy makers may afford to stick to current status of policies, if those policies seem to be delivering faster growth rate compared to other fast growing economies in the world. But if GDP growth rate comes down to meager 4.5% instead of the expected 7%, then both fiscal and monetary policies need to be revived without any delay. Special care should be taken to get rid of corporate and financial system stress, new initiatives or projects that do not have high expected outcome. "Jobless growth" is not enough even if apparently "good growth". Another very important aspect is maintaining quality and integrity of data. The methodological changes that took place between 2012 and 2014, has a great impact on economy of India. The authors conclude by saying that statisticians and technocrats need to reconsider logics behind forming those policies and corresponding effects.

Reference [14] applies a Bayesian vector auto-regression (BVAR) technique which accepts variables of two kinds – sector and monetary variables. Sector variables consist of domestic aggregate demand and foreign variables. Monetary sector is particularly concerned with the measurement of inflation. Consumer price index (CPI) versus wholesale price index are two components of targeting inflation. The authors have experimented with over 3000 BVAR models to evaluate their predictive capability based on statistical accuracy of GDP forecasting. Authors conclude by saying that incoming flow of capital and CPI inflation are highly responsible behind India's GDP growth rate at any point of time. Please note that the time period considered in this paper is from 2004 to 2018. Some other important time series models like VARs, SVARs and ARIMAS have been considered.

In reference [15], authors have collected historic GDP data from 1951 to 2014. From there, GDP of India has been predicted upto 2020. A detailed statistical analysis showed that India's GDP potential to grow is higher than what is observed due to adverse reactions. Reference [16] proposes a time-variant parameter based regression method to forecast growth in GDP. The model is dependent on a huge number of variables – fiscal, monetary, trade and production. There are two prominent aspects or sides of a model – demand side and supply side. Supply side typically comprises of the attributes of production, whereas rest of the variables belong to the demand side. Hence the combined model seems to be more complete in terms of number and variety of parameters it considers. Time varying characteristics of these parameters make it more close to real life. Therefore, statistical accuracy of the TVPR model (time varying parameter regression) is significantly higher than limited vision models like constant parameter factor augmented regression model and dynamic factor model. Reason is that, considering time variant characteristics of demand, statistical error of forecasting total GDP and GDP of industries, are minimized. As far as minimization of errors to predict GDP of service industries is concerned, that is taken care of by supply side of a model. Overall, the demand and supply side together, maximize accuracy of predicting total GDP.

Article [17] mentions that India took recourse to a newer extensive dataset and corresponding innovative methodologies, so that GDP calculation procedure can keep parity with United nation's standard. Change in base year took place from 2004-5 to 2011-12 in the series from MCA-21 which is suitable for being used for organized private sector. It is a big database containing balance sheet and other data of almost each and every company in

India. Each company is associated to a 21-digit special identification number, distinct for each one of the companies. Therefore, the new name MCA-21comes into the picture. Full form of MCA is Ministry of Corporate Affairs. Changes that took place in the new series are in terms of both base year and data. Change in base year is typically dependent on demand of the era and trajectory of economy. It has normally been seen that whenever there is a change in base year, GDP jumps to a higher number and researchers have focused on estimation of this growth. Another concern is backward calculation with the new base. For that, Indian Statistical System has utilized an alternative database system termed as CMIE corporate database.

III. Forecasting GDP – Rest of the World

Article [18] analyses evolving economy of five developing countries – Brazil, Turkey, South Africa, Mexico, Indonesia and tries to assess their GDP by analyzing its potential parameters. Definitely some kind of uncertainties are involved in it, some surprise factors are there that keep on influencing future GDP. The authors experiment with two different kinds of models including simple benchmark linear econometric model and dynamic factor model. Estimation is performed using a variety of frequency based operators and Bayesian operators. The time period considered in [19] is from 1978 to 2017; context is Jordan. Data collection was performed from Jordanian's department of statistics. The softwares used to statistically analyze the data, are Minitab and Matlab. The time series data is a huge one, which needs to be divided into parts of relevance using wavelength transformation, thus eliminating abnormal fluctuations or outliers. Then ARIMA(2,2,1) model is applied for analysis of the transformed data and estimating GDP. Authors claim that as per simulation result, estimated GDP values are within 5% of exact or actual value. Hence, quality of prediction is very efficient in modeling GDP for 20 long years. . Also it shows that economy of Jordan is expected to substantially improve in next 20 years. Only thing is that Government needs to be progressive and optimist. More progressive and growth enhancing reforms should be taken to strengthen the economy.

From rest of the world perspective, we now look at the Egyptian economy [20], where again ARIMA model is applied for prediction of GDP. Time period for which data has been collected is from 1965 to 2016, and GDP is predicted for ten subsequent years. The optimum ARIMA model is chosen using Ben-Jenkins approach. In this approach, one ARIMA model candidate is taken at a time and its parameters are computed. Based on these parameters, GDP for next year is predicted. The model that gives highest accuracy of prediction, is chosen as optimal. In [21] data of GDP from 1952 to 2007 are collected from Shaanxi statistical yearbook. SPSS statistical software is applied with ARIMA(1,2,1) time series model to do the prediction. The authors of [21] have estimated values of parameters p and q of ARIMA(p,d,q) model from three things – scatter diagram, ACF graph and PACF graph. The GDP of Shanxi province for the period 2008-13 is estimated by this model and accuracy is almost 5%.

In [22] the authors proposed GDP of China from 1978-2014. An ARIMA(2,4,2) model has been established and implemented using Eviews60 software. GDP is forecast for next 5 years and estimated value is calculated with real value at each stage., to measure approximate accuracy of the model. The authors claim that ARIMA(2,4,2) model is more suitable for GDP prediction compared to earlier models. On the other hand, in [23],

the author initially expresses utility of GDP as a very important macro-economic indicator of progress in a country. Real life data of GDP from the year 1996 to 2017 has been considered. This data was released quarterly; more specifically, if we say then input data was from second quarter of 1996 to first quarter of 2017. The forecasts demonstrate a converging nature in the long run although certain outliers or shocks can be noticed in the short run. For example, the year 2008 showed a completely different trend from usual converging value.

The article [24] studies the economy of Greece from 1980 to 2003 using Box-Jenkins methodology and ARIMA(1,1,1) model. Then values of GDP of Greece for the years 2015 to 2017 have been estimated, to arrive at the conclusion that real GDP rate of Greece is steadily improving. The reference [25] proposes a scheme where real GDP values and logarithm of year wise changes in real GDP, are stored. Then using Box-Jenkins approach, the model with highest adequacy is identified. For that, characteristics like stationarity and invertability needed to be experimentally examined to identify residuals. Next step was to do the forecast which could be either multi-step forecast or one step ahead rolling forecast. Finally, accuracy of the predicted value is compared with the same of AR(1) model to arrive at the optimal estimation. Reference [26] throws light on predicting GDP of the entire Europe. Required data is available at "Eurostat" which is statistical office of whole Europe, located at Luxembourg, which is authorized by European Union. Therefore statistical data of nineteen countries like Belgium, Germany, Ireland, Lithuania, Luxembourg, Estonia, Italy, Netherlands etc. During prediction of GDP, trend, seasonality and cyclicity have to be identified from available data. Trend is a pattern that shows overall general tendency of the data ignoring the outliers. Seasonality is a pattern that repeats itself after a specific time interval. Cyclicity is another kind of pattern that exhibits rise and fall that are not of a fixed period. Time series forecasting is performed using ARIMA model to express auto-correlation between GDP values of different years. A series of models are examined and from them, the one that is best suited for the given data, is used to predict GDP in next stage. References [27-30] apply the same ARIMA model for predicting GDP.

Article [32] considers certain ASEAN countries like Malaysia, Thailand, Singapore and applies a special too termed as Relevance Vector Machine (RVM) to estimate GDP. RVM is based on the concept of neural networks. Research has proved it successful in many applications that require analyzing number of occurrences of some event from history. Forecasting of GDP is performed based on this time series analysis. RVM considers both training data and validation data. It's functions are governed by certain kernels with each kernel corresponding to one data point from the training data set. Through simulation results, the authors have successfully established that RVM provides more accuracy than auto-regressive model. Reference [34] studies Romanian economy to analyze influences of certain economic variables to predict GDP. Various econometric models are there to serve the purpose like AR, VAR, VARMA etc. Research has proved that VARMA models produce more accurate predictions [34]. As far as relative importance of variables or parameters are concerned, unemployment rate, exchange rate and rate of monetary supply generate more accurate prediction than simple random walk.

The authors of [37] applied neural-networks and Box-Jenkins approach to evaluate and mutually compare multiple methods and the one that produces highest accuracy, is elected as optimal and chosen for GDP prediction in next quarter, based on GDP in every earlier quarter. We are all aware of different applications of GDP and [42] is an article elaborately demonstrating it. It targets the country China and develops a new logistic model for energy

consumption, as a function of change in GDP. In reference [48], a dynamic factor model has been proposed to determine short-term growth of GDP in the short time. A transfer function is applied which utilizes a common factor comprising of 31 economic indicators associated to domestic production, domestic trade flows and labour market. To dynamically identify the common factors from economic indicators, Kalman filters have been used in [42]. Since a significant number of matrix operations are required, MATLAB is chosen as the underlying software.

The article [49] considers economy of two different countries China and Vietnam to predict GDP for next 10 years. This is another application of the very well known ARIMA model. It is fitted to time series data for both the countries. Based on the input data from 1996 to 2017, it came out that the best fit result for China is ARIMA(2,3,5) whereas the same for Vietnam is ARIMA(2,3,1). Please note that both these countries have open economy and domestic credit of both of them significantly contributes to growth of GDP. This helps policy makers to have a general view of open economies across the world.

Purpose of article [50] is to estimate GDP at current timestamp (nowcast) and at subsequent timestamps later than current one (forecast). It assumes that status of macro-economic variables is available from history in both monthly and quarterly terms. These are linked using bridge equations, to efficiently perform the nowcast and the forecast. Please note that accuracy of nowcast plays a significant role in every forecast after it and each forecast has got significant influence over subsequent forecast. Both K-nearest-neighbor approach and parametric vector auto-regressive model has been used in this paper for accurate GDP estimation. Simulation results show that K-nearest-neighbor approach produces better result than parametric vector auto-regressive model.

IV. Conclusion

The present article discusses about the different methods of estimating GDP. Most of the models used in this are ARIMA(p,d,q) model based. Values of p, d and q are determined based on the previous record of GDP. Both nowcast and forecast are performed separately. Nowcast is current level forecast. All subsequent forecasts are termed as forecasts in general. For accuracy in all these predictions, macro-economic parameters have to be identified as many as possible and their comparative relevance or approximate influence over next stage GDP is analyzed. Certain articles in literature of GDP prediction have used special concepts like neural network, K-nearest-neighbor approach etc.

References:

1) A. Girardi, C. Gayer and A. Reuter, “The Role of Survey Data in Nowcasting Euro Area GDP Growth”, Journal of Forecasting, vol. 35 issue 5, 2015

2) Garnitz J., Lehmann R. and Wohlrabe K., “Forecasting GDP all over the world: Evidence from comprehensive survey data”, MPRA paper no. 81772, 2017

3) I. Visco, A. Bassanini, S. Scarpetta,"Knowledge, technology and economic growth: an OECD perspective", Research Series, May 2000.

4) J.J. Vanhaelen, L. Dresse, J. De Mulder,"The Belgian industrial confidence indicator: leading indicator of economic activity in the euro area", Document Series, 2000

5) L. Aucremanne and D. Cornille, "Attractive Prices and Euro - Rounding effects on inflation" by, Documents Series, November 2001.

6) D. Jorgenson, "Lifting the burden: fundamental tax reform and economic growth", Research Series, May 2002

7) Ch. P. Himmelberg, R. G. Hubbard, I. Love," Investment, protection, ownership, and the cost of capital", Reearch series, 2002

8) P. Butzen, C. Fuss and Ph. Vermeulen,"The interest rate and credit channels in Belgium: an investigation with micro-level firm data" by Research series, December 2001.

9) D. Cassimon, P.J. Engelen, H. Meersman, M. Van Wouwe, "Investment, uncertainty and irreversibility: evidence from Belgian accounting data", Research Series, 2002

10) L. Trigeorgis, "What do we know about investment under uncertainty?", Research Series, 2004

11) B. Maity, B. Chatterjee, "Forecasting GDP growth rates of India: An Empirical Study, International Journal of Economics and Management Science, vol. 1, pp. 55-58, 2012

12) http://www.igidr.ac.in/pdf/publication/WP-2017-018.pdf

13) A. Subramanian, "India's GDP mis-estimation: likelihood, magnitudes, mechanisms and implications", CID Faculty Working Paper No. 354, June 2019

14) T. Iyer, A. Sengupta, "Quarterly forecasting model for India's economic growth: Bayesian Vector Auto-regression approach", ADB Economics Working Paper Series, 2019

15) R. Changle, S. Matharu, "A study of forecasting the GDP of India using ARIMA model", SAMVAD International Journal of Management, SIBM Pune, 2015

16)R. Bhattacharya, P. Chakravartti and S. Mundle, "Forecasting India's Economic Growth: A time varying parameter regression approach", working paper series no. 238, National Institute of Public Finance and Policy, New Delhi, 2018

17) Naliniprava Tripathy, Harsh Alipuria, "GDP calculation: Old vs New; here's how India measures economic growth", Financial Express, June 12, 2019

18) O. Cepni, I.E. Guney, N.R. Swanson, "Forecasting and nowcasting emerging market GDP growth rates: The role of latent global economic policy uncertainty and macro-economic data surprise factors", Journal of Forecasting, vol. 39 issue 1, 2019

Received: 02 Dec 2019 | Revised: 24 Jan 2020 | Accepted: 16 Feb 2020

19) D. Alsinglawi, "Predicting Jordanian's GDP is based on ARIMA modeling", Italian Journal of Pure and Applied Mathematics, Feb 2019

20) M.R. Abonazel, A.I.A-Elftah, "Forecasting Egyptian GDP using ARIMA models", Reports on Economics and Finance, vol. 5 no. 1, 2019

21) W. Ning, B. Kuan-Jiang, Y. Zhi-fa, "Analysis and forecast of Shanxi GDP based on the ARIMA model", Asian Agricultural Research, vol. 2 no. 1, 2010

22) B. Yang. Et. Al., "Application of ARIMA model in the prediction of gross domestic product", Advances in Intelligent Systems Research, volume 130, 2016

23) V. Agarwal, "GDP modeling and forecasting using ARIMA: An empirical study", Thesis submitted to Central European University, Hungary, 2018

24) Dr. Chaido Dritsaki, "Forecasting real GDP rate through econometric models: An empirical study from Greece", Journal of International Business and Economics, vol. 3 no. 1, 2015

25) www.rsudio-pubs-static.s3.amazonaws.com/250143-9f48aa8f32d54b82876822b03973e4f3.html

26) www.towardsdatascience.com/forecasting-gdp-in-the-eurozone-54778f79912e

27) A. Uwimana, BI. Xiuchun, Z. Shuguang, "Modeling and forecasting Africa's GDP with time series models", International Journal of Scientific and Research Publications, vol. 8 issue 4, 2018

28) M.S. Wabomba, M. P. Mutiwari, M. Fredrick, "Modeling and forecasting Kenyan GDP using ARIMa models", Science Journal of Applied Mathematics and statistics, vol. 4, issue 2, 2016

29) E.A. Anderi, E. bugudui, "Econometric modeling of GDP time series", Theoretical and Applied Ecconomics, vol. XVIII, no. 10(563), 2011

30) T. Nyoni, L. Muchingami, "Modeling and forecasting Botswana's gross domestic product per capita, MPRA paper, 2017

31) M. Zakai, "A time series modeling on GDP of Pakistan", journal of Contemporary Issues in business research, vol. 3 no. 4, 2014

32) S. Chanaim et. Al., "Forecasting GDP in Asian Countries using relevant vector machines",Thai Journal of Mathematics, Special issue on Structural change modeling and optimization in econometrics, 2018

33) M. Iacoviello, "Short term forecasting: projecting Italian GDP, one quarter to two years ahead", IMF Working paper 2019

34) M. Simionescu, "The accuracy assessment of macro-economic forecasts based on econometric models of Romania", Procedia economics and finance, vol. 8, 2014

35) T. xie, "Research on GDP forecasting models of Heilongjiang province in China using long term series night-time light data", 2019

36) A.K. Singh,"An empirical analysis to assess the GDP projection of Gujrat state of India, JNNCE Journal of Engineering and Management, 2017

37) L. Dvorakova, "CZ GDP prediction via neural networks and Box-Jenkins method", 39th SHS Web of Conferences, 2017

38) www.christophsax.com/2017/05/02/forecasting-gdp/

39) Economics division, Ministry of Finance and Economic Management, Cook Islands time series, economic forecasting model, working paper no 18/1, 2018

40) Economics division, Ministry of Finance and Economic Management, Cook Islands time series, economic forecasting model, working paper no 18/1, 2018

41) J. Yip, "Forecasting economic risk in the EU into 2020", 2017

42) X. Cui, W. Zhao, "Study of the modified logistic model of Chinese electricity consumption based on the change of GDP growth rate under economic new normal", Mathematical problems in engineering, 2019

43) H. Zhang,"Modelingand forecasting regional GDP in Sweden using auto-regressive models", Maters thesis, School for technology and business studies, Dalarna university, 2013

44) M. Taht," Seasonal adjustment and forecasting of quarterly gross domestic product: Estonian experience", Conference on Seasonality, Luxemborg 2006

45) G. Feng et. Al., "Liaoning province economic increasing forecast and analysis based on ARMA model", IEEE International Conference on Intelligent Networks and Systems, 2010

46) J. Garnitz, R. Lehman, K. Wohlrabe, "Forecasting GDP all over the world using leading indicators based on comprehensive survey data, Applied Economics (Taylor and Francis), vol. 51, 2019

47) S. Bhaduri, S. Pohit, "Nowcasting the Indian econmy: A new approach to know the now GDP", 2018

48) A. Cuevas, E.M. Quilis, "Forecasting GDP with a dynamic factor model", Mathworks, 2018

49) D.V. Dinh, "Forecasting domestic credit growth based on ARIMA model: evidence from Vietnam and China", Management Science Letters, vol. 10 issue 5, 2019

50) D. Guegan, P. Rakotomarolahy, "Alternative methods of forecasting GDP", 2010

Received: 02 Dec 2019 | Revised: 24 Jan 2020 | Accepted: 16 Feb 2020