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MACHINE LEARNING FOR GROSS DOMESTIC PRODUCT VALUE FORECASTING IN THAILAND DURING COVID-19 SITUATION

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ABSTRACT

The situation has affected the global economy this year trending into a recession, forcing governments in many countries around the world to accelerate economic stimulus measures to mitigate the impact of COVID- 19, according to the World Economic Forum 5 report. This pointed out that the money spent by each government on this occasion was significantly larger than in the past. Advanced economies injected 14% to 28% of gross domestic product (GDP), while emerging economies accounted for around 4% of GDP. Thailand were close at 9%. This crisis is like a war in which humans have to fight an invisible enemy and no nation can escape from an economic recession. But the size of the impact and the direction of recovery of each country are different depending on 4 factors: (1) the duration of the lockdown which depends on the epidemic and people's cooperation; (2) the level of economic dependence countries that are linked to global production chains or are highly dependent on exports and tourism will have a higher impact; (3) Economic fundamentals. The economy in many countries has been in low growth for a long time. Some countries have been affected by the trade war. While some countries have flooded debt problems, causing the economy to be like a chronic patient that may recover more slowly; and (4) the government's economic stimulus measures which can be regarded as a strong medicine that is necessary for the economy to recover.

Keyword: Machine Learning, Gross Domestic Product, Forecasting

INTRODUCTION

Currently, many countries around the world have started to relax lockdown measures to mitigate the economic impact, especially in countries that have controlled the epidemic well, such as China, South Korea, Japan, Thailand, but many people are still worried about the second or third wave of the outbreak because of the COVID-19 [1]. 19 is an emerging disease that we do not yet have much information about. Including there is no preventive vaccine. As a result, there are various opinions on recovery modes, which can be summarized into 5 patterns. Economic models can be used to model the consequences of pandemics. [2]

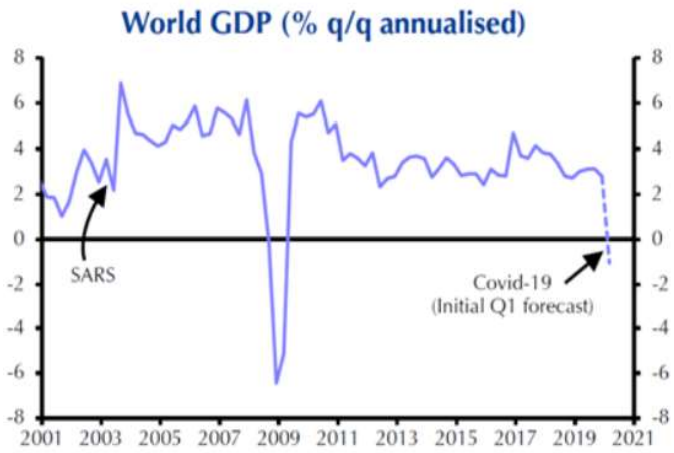

Figure 1. Comparison of world GDP compared between SAR and Covid-19.

There will be a wide range of tax income for the government. The state government plans to invest tax money in infrastructure for public utilities. Facilitating household budgets and savings by encouraging and bolstering the commercial sector. GDP is a metric that can be used to quantify the outcomes. If GDP is up from last year, the economy as a whole has expanded. Investment from both the public and corporate sectors as well as consumer expenditure has increased. also, the worth of exports exceeds that of imports. GDP projections for 2018 are 4.4%, which means that the economy expanded by that amount from 2017 to 2018. If the GDP is negative, however, it suggests that economic growth has slowed or stagnated, or that official economic forecasts are off. Employment levels could be lower than anticipated. Investment in industry saw a decline. Spending by the government is lower than anticipated. Consumption is down even among the general public. When the GDP number is negative, investors are more likely to put their money into growing or more stable markets. Gross domestic product is a measure of economic health. That can reveal the annual expansion of the home economy or decrease by how much, but this does not account for the fact that the product or service may not always be used to improve people's lives. It's a result of living a miserable existence. The expenditures stemming from excessive borrowing leading to high levels of household debt; rushing company expansion to the point that the impact on communities and the environment is ignored, etc.; have a negative effect on society and the environment. The Human Development Index (HDI) created by the United Nations is one example of an alternative method of assessing development that places more emphasis on social and environmental factors. The New Economics Foundation's Happy Planet Index; nevertheless, other nations have opted to create their own metrics, such as Bhutan's Gross National Happiness Index. (GNH). Including, but not limited to, the Happiness Index: Australian Unity. For trending or analyzing big data. At present, if such data is very large efficiency of using economic models is less efficient and effective than machine learning [3], Harding and Hersh [4] compared the model as shown in picture 2.

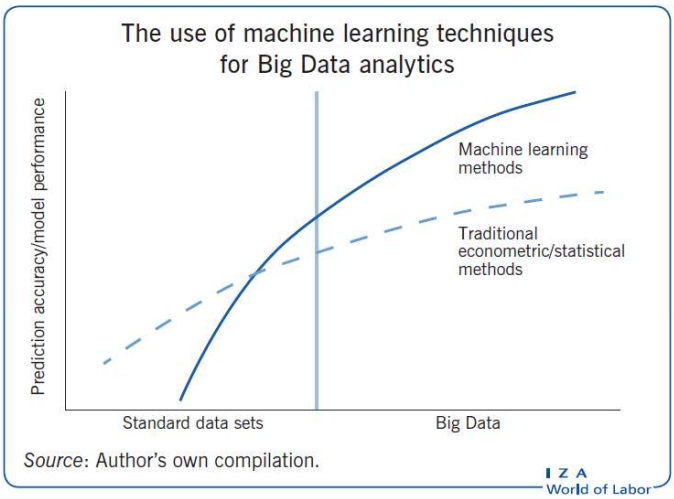

Figure 2. The use of machine learning with general statistical and economic models [4]

Nowadays, Machine Learning can be applied to a variety of [4] such as finance, marketing, target group Engineering, production, maintenance, medical or research in various fields as well and has been used to analyze big data in various forms [5], causing the working group to be interested in applying Machine Learning to find models that related to the national income of Thailand.

OBJECTIVE

1. To develop a functional structural model of a neural network for analyzing Thailand's gross domestic product.
2. GDP analysis and compare them with other institutions and directly affect the country's gross domestic product

EXPECTED RESULTS

1. Get a working structure model of the neural network in analyzing the GDP of Thailand.
2. The gross domestic product analysis and comparison with other institutions and directly affect the country's GDP

THEORY

Basic knowledge of GDP

Domestic Product (GDP) is the sum of the value of final goods and services produced in a country over a period of time, excluding the value of raw materials and other products used for that product, with GDP often being one of the key economic indicators to be a rough representation. Thus, tracking GDP growth reflects changes in the income earning capacity of people as a whole. It is often a useful index for investors as GDP growth is an indicator of how a country has a better income-generating capacity to reinvest its assets for higher returns benefit from Measuring GDP growth to be used as one of the indicators to measure the effectiveness of public policy in the economy. [5],[6]. Theoretically GDP can be divided into three forms: (1) production or supply GDP, i.e. The sum of the added value of each stage of production,

which is the sum of selling prices minus costs; (2) Consumption or demand -side GDP is the sum of the values of final consumed goods, such as food consumption medical treatment Overall, it consists of private consumption Government Consumption Foreign consumption or export And investment in the purchase of machines or tools to be used in production and (3) income GDP is the sum of the income of labor income and profits from entrepreneurs. All three forms of GDP must be accounting for a certain period of time In Thailand, the Office of the National Economic and Social Development Council is the main data collector of the country's GDP data.[7]

Basic knowledge of forecasting

This research is quantitative is a forecast that uses quantitative data in the past to forecast future values by creating a mathematical model This type of forecasting is divided into 2 sub-techniques:

1. Relationship forecasting is a technique that uses factors that are expected to correlate with variables to be forecasted, for example, if wanting to forecast sales. Will consider the relationship between sales and advertising costs population income, commodity condition, etc., finding such a relationship. It uses techniques known as correlation analysis and regression analysis.

2. Time series forecasting is a technique that uses only the past data of the variables to be forecasted to predict the value of that variable in the future. The time series analysis (Time Series Analysis) is the use of time series data, that is, data that occur in sequences of time that are equally spaced continuously for a long time analyzing the relationship**.**

Neural network theory

Neural Network (ANN) Jena, Majhi [5],[8] is a branch of artificial intelligence (AI). Respond to input according to the learning rule after the network has learned what it needs [9]. The network will be able to perform a specific task. An artificial neural network has been developed from the work of the human brain. The human brain consists of processing units called neurons (neurons or neurons) human brain. There are about and there are many connections. The human brain can therefore be said to be an adaptive, nonlinear, and parallel computer that manages the interaction of neurons in the brain[10],[11]. Neural computation is a computation that mimics the work of the human brain. Back propagation neural network. As shown in Figure 3.

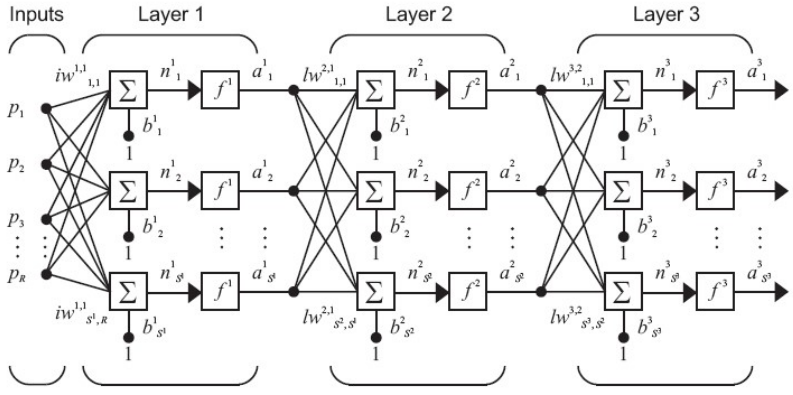

Figure 3. Multi-layer neural network model [12].

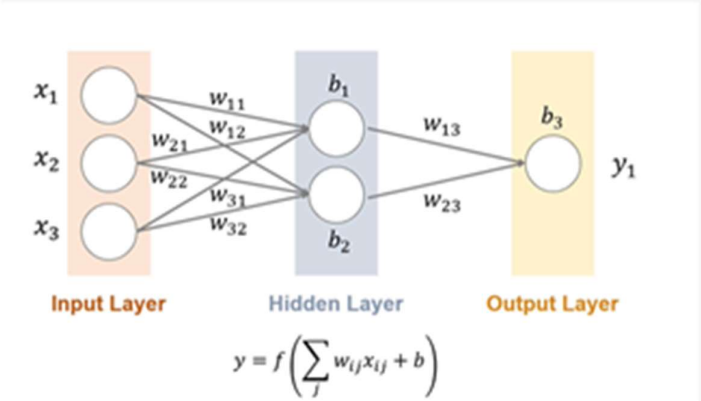

Figure 4. Multilayer neural network model, multilayer, 1 layer, hidden

The figure, it consists of an input layer, a hidden layer, and an output layer. The activation function in each layer is described in equations (1)-(3).

$$a = \log sig(n) = \left(\frac{1}{1+e^{-n}}\right) \quad (1)$$

$$a = \tan sig(n) = \left(\frac{2}{1+e^{-2n}} - 1\right) \quad (2)$$

$$a = purelin(n) = (n) \quad (3)$$

Reverse computation (backward computation), when the calculated results have discrepancies will start the process of calculating backwards which starts from adjusting the weight between the resultant layer and the latent layer and go back to the data receiving level. The method used to adjust the Weight is Steepest Descent which can be described as equation (4) – (5).

$$w_j^r(new) = w_j^r(old) + \Delta w_j^r(new) \quad (4)$$

$$\Delta w_j^r(new) = \alpha \Delta w_j^r(old) + \mu \sum_{i=1}^{n} \delta_j^r y_i^{r-1} \quad (5)$$

where r is the hierarchy of the neural network.

α is the momentum factor.

μ is the learning rate

α is the Slop Parameter

j is the network in layer j. linked from the input layer

Polynomial neural network

Polynomial Artificial Neural Network [12] is an architecture developed from artificial neural networks. [5] Based on the Group Method of Data Handing (GMDH) [10] and the principles of Polynomial Regression developed by Ivakhvenko. In the 1960s, polynomial neural networks were capable of predicting data stored in time series and able to effectively solve the problem of data that is not in a linear format (Non-linear) than simple neural networks. [13] Polynomial

neural networks use the basic theory of GMDH (Group Method of Data Handling) can be explained from the equation

$$y = a_0 + \sum_{i=1}^{M} a_i x_i + \sum_{i=1}^{M}\sum_{j=1}^{M} a_{ij} x_i x_j + \sum_{i=1}^{M}\sum_{j=1}^{M}\sum_{k=1}^{M} a_{ijk} x_i x_j x_k + \ldots (6)$$

where $x_1, x_2, \ldots x_k$ is the vector of the input variable

$a_0, a_i, \ldots a_{ijk}$ is the vector of the coefficient or weight (weight)

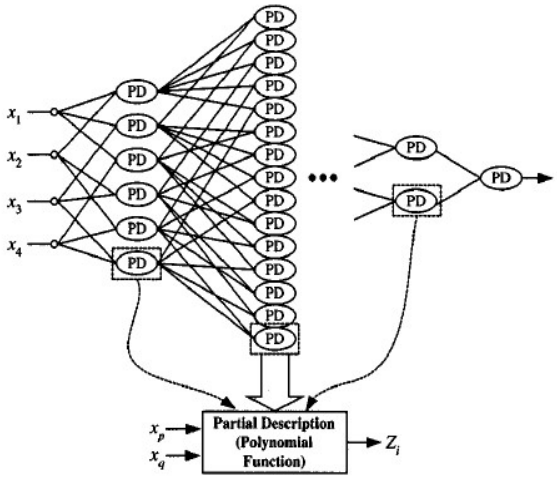

Figure 5. Basic architecture of polynomial neural networks

Polynomial neural networks can be applied to many functions such as Linear Function, Quadratic Function, Cubic Function as the behavior of the polynomial artificial neural network in a number of nodes is described in Figure 6.

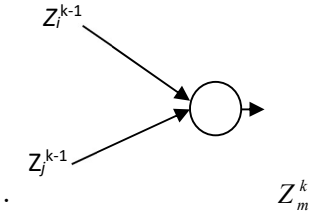

Figure 6. Characteristics of a polynomial neural network, nodes

Figure 6, the input data in the part of the polynomial neural network Which from the picture has 2 input data, consisting of Z_i^{k-1} and Z_j^{k-1} and resultant data when passing the function, which is The resulting function in one Z_m^k node can be described as Equation (7).

$$z_m^k = a_m^k (z_i^{k-1})^2 + b_m^k (z_i^{k-1})(z_j^{k-1}) + c_m^k (z_j^{k-1})^2 + d_m^k z_i^{k-1} + e_m^k z_i^{k-1} + f_m^k \qquad (7)$$

Equation (7), it can be seen that the Output function (z_m^k) consists of a weight of 6 weight by applying the equations of GMDH to be able to work together, also known as GMDH Polynomial Neural Networks, which can reduce the complex structure of the network can reduce

RESEARCH METHODS

Model development

Model development using- multi-layer neural network that uses Backpropagation learning by setting the learning rate parameter in the range of 0 to 1, the momentum in the range of 0 to 1, and the training cycle at 300, 500, 800, 1,000 and 1,500. Remember, try to find The developed forecasting model sets learning rate equal to 0.3, momentum equal to 0.2, and training cycle equal to 1,000 least mistake When data is imported, it is processed by multiplied by the weights (weight ,W), representing the significance of each input data, plus the bias (bias, b), which is the sum of the weighted adjusted data and the bias adjustment is passed to the offloading function. transfer (transfer function) which has equations for calculating the result as equations (1) – (3)

Data Set

The data used are historical national income data of Thailand. Office of the National Economic and Social Development Council There are 4,250 data counts. Records from 2005- 2021 is a linear time series data and there is constant movement with the following factors affecting.

Data analysis

Table 1 Details of data used in the research

Attribute	Meaning
Agriculture, forestry and fishing	Agriculture related income information.
Manufacturing	Revenue information related to the production of goods.
Transportation and storage	Transport information.
Service	Revenue data in the service business group.
tourism inbound	Inbound tourist information.
tourism outbound	Outbound tourist information.
Partner	Partners.
GDP	Gdp data.

Table 1, the data used as historical national income data of Thailand. Office of The National Economic and Social Development Council There are 4,250 records from the year 2005. Year 2021, information consisting of Attribute, income information related to agriculture revenue information related to the production of goods transport information Revenue data in the service business group inbound tourist information outbound tourists, suppliers and GDP data (Y) Retrospective when using retrospective GDP data to find trends as in Figure 7 The linear equation is Polynomial order 2 equal to y = - 1 E- 07 x 2 + 0.0087 x - 150.8.

Figure 7. Time Series of Thailand's GDP from 1991 - 2021

Research design

After going through the collection process and To prepare the data, the researchers used the split test method of RapidMiner Studio 7 and Matlab 2020a which is divided random data by dividing the dataset into two parts Including the training set (training set), accounting for 80 % of all data to be used for model development multilayered neural prosthesis test data set representing 20 percent of all data to use in Model performance testing, which uses Item 7 Attributes using RapidMiner Studio 7 and Matlab 2020a. programmed Successfully analyzed development data.

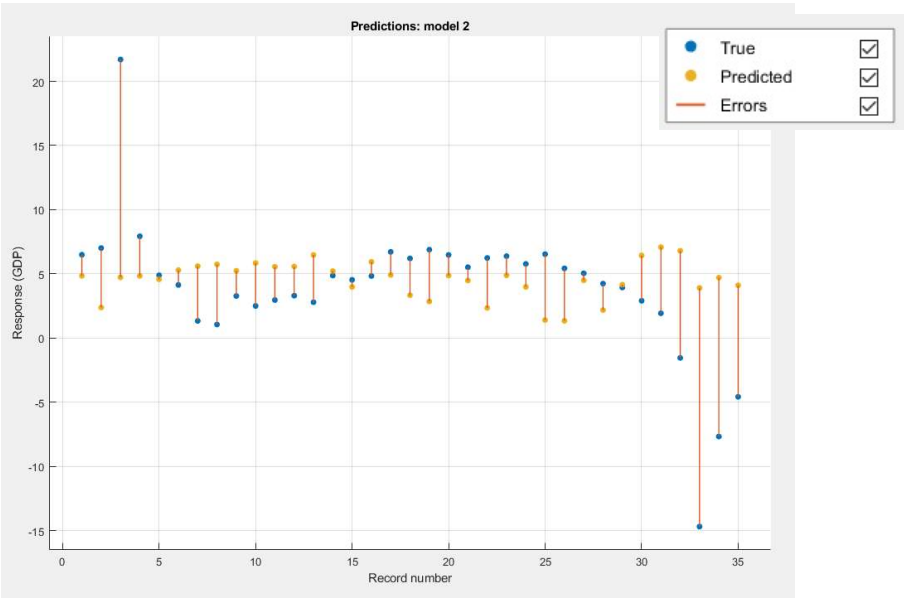

Figure 8. Predicted Model using Linear Regression

Data Transformation

The transformation of the forecasted data to be suitable for each technique and algorithm. Because the data groups have very different values, it is not suitable to be used in the model. Must find the maximum and minimum values of the data group and reduce the size

of the data to be in a range suitable for use in teaching in the network which is converting the value of the data into the range (0 to 1) by using Equation (9).

$$P_n = \frac{P - P_{\min}}{P_{\max} - P_{\min}} \qquad (9)$$

After the result is obtained, it must be converted back to its true value by Equation (10).

$$P = [P_n(P_{\max} - P_{\min})] + P_{\min} \qquad (10)$$

when P_n is the value obtained from the equation

P is the data value before passing the equation

$P_{\max}$ is the highest data value before passing the equation

$P_{\min}$ is the lowest data value before passing the equation

Measuring model accuracy

The measure of forecasting accuracy is measured from the data set showing the least square mean error and percentage accuracy, as in Equation 1.

$$MSE = \frac{1}{n}\sum(y_k - \hat{y}_k)^2 \qquad (8)$$

when y_k is actual value

$\hat{y}_k$ is forecast value

N is number of predicted values

RESEARCH RESULTS

Performance of Neural Networks

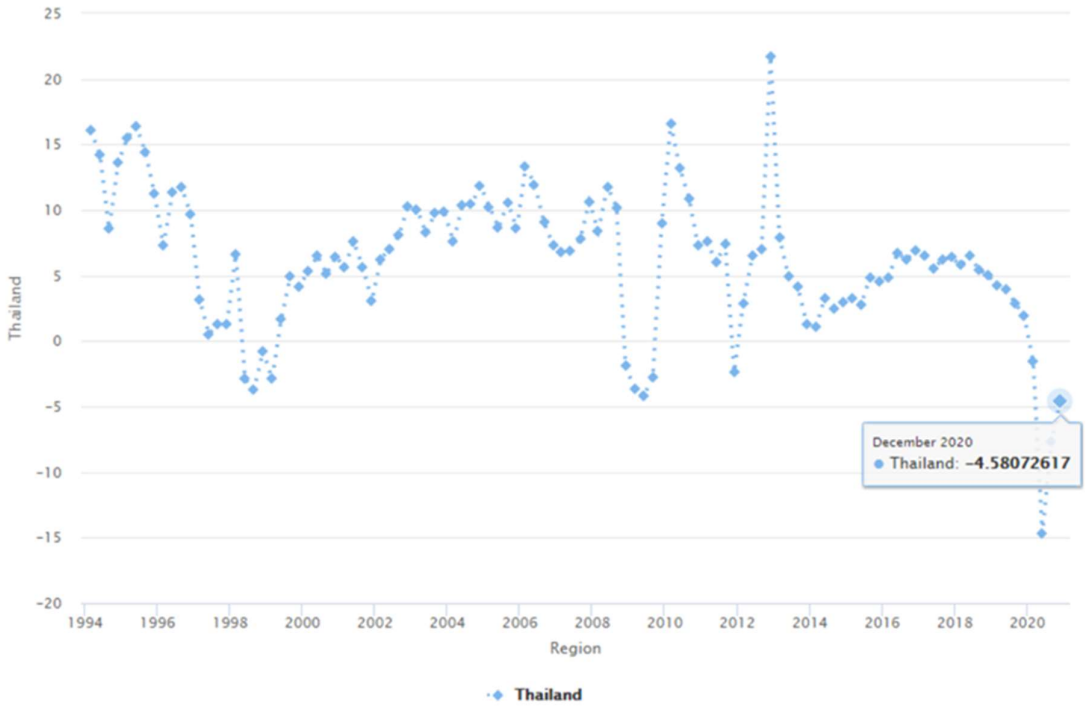

Figure 9. Trends in GDP from 1994 - 2010

The historical data of GDP from the Bank of Thailand from 1994 - 2010. It can be seen that at the end of 2010, it was during the COVID epidemic situation, the GDP value was negative 4.580, but in the beginning of the year 2021 GDP data has moved higher.

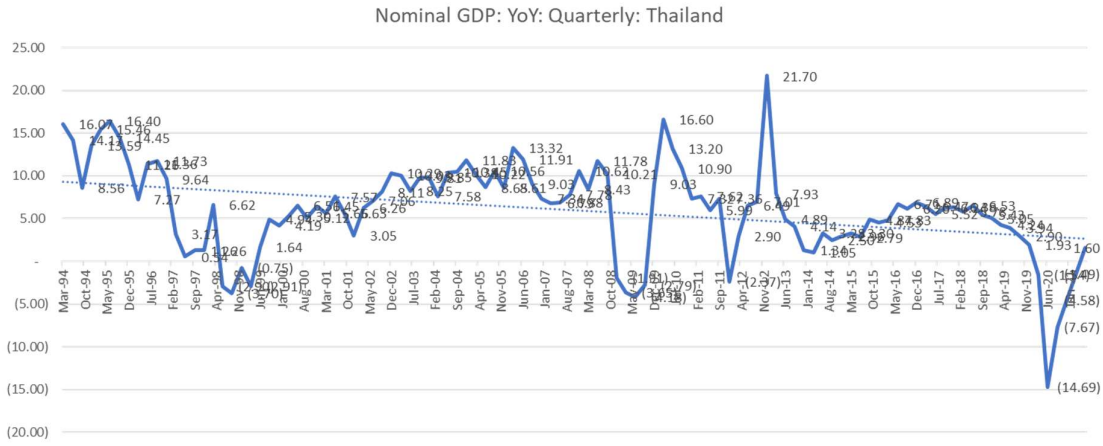

Figure 10. The model uses a data set.

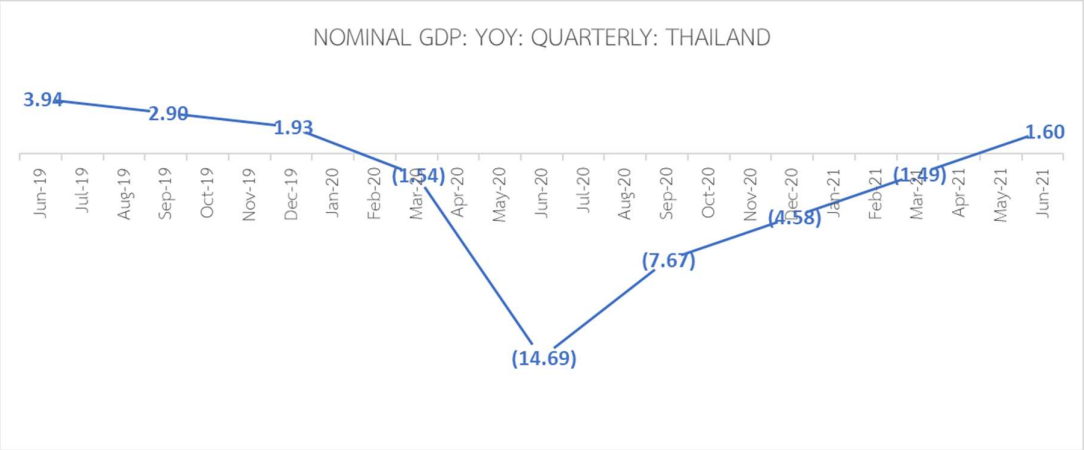

Figure 11. Model forecasts over a short period of time, quarters

Figure 10 and 11, the analysis of GDP figures from July to September 2021 is expected to increase GDP from -1.49, expanding in a positive direction, 1.60-GDP is positive. Represents an overview of the economy that is growing. There is more money in circulation in the country. But what may follow is that the inflation rate will increase as well because when people want to buy more can push the price of the product to increase.

Table 2 Economic expansion during 2021 - 2022 (after vaccination) (Bank of Thailand, 2021)

	Case 1 procure and distribute additional vaccines (100 million doses in 2021)		Case 2 procure and distribute original planned vaccine (64.6 million doses in 2021)		case 3 supply and distribution of vaccines slower than the original plan (less than 64.6 million doses in 2021)	
Herd immunity period	Q1/65		Q3/65		Q4/65	
year	2021	2022	2021	2022	2021	2022
GDP (%YoY)	2.0	4.7	1.5	2.8	1.0	1.1
Foreign tourists (million people)	1.2	15.0	1.0	12.0	0.8	8.0
The impact on the economy if vaccination is	-		-3.0 % of GDP		-5.7 % of GDP	

delayed until the Herd Immunity did not catch up with the 1/65 quarter*		(4.6 billion baht)	(8.9 billion baht)
unemployed / quasi unemployed At the end of the year 65 (million people)	2.7	2.8	2.9

CONCLUSION

The GDP value shows how the economy of a country has changed over time. Which can be used to figure out how big the economy is and how fast it is growing inflation and the number of people in a country can also be used to change how GDP is calculated as a more in-depth way to look at it. It is also a useful tool for policymakers, investors, and people who own businesses. used in the future as a guide for making strategic decisions. Gross domestic product, or GDP, is a way to measure the size of an economy. It shows how much economic activity is going on in a country. The GDP gives a broad picture of the country's economic growth, but it also shows how much money the country makes from the goods and services it makes. It is also used as a strategic tool by investors, business owners, and people who make decisions about the economy and money. If the GDP is negative, on the other hand, it means that the country's economy has stopped, slowed down, or is not what the country's central bank thought it would be. There is a chance that the number of jobs will be lower than expected. Investment in industry went down. Spending by the government is less than was thought. Even the public's use of things has gone down. If the GDP number is negative, investors will be more likely to put their money into markets or economies that are more stable and growing.

GDP is a way to measure the size of the country's economy. That shows how much the domestic economy has grown each year or decrease by how much, but can't measure the real quality of life because sometimes the product or service will be sold. It comes from not being happy with life or hurting society and the environment, like when people spend too much because they borrow too much and end up with a lot of debt, or when businesses grow too fast and don't care about how it affects communities and the environment, etc. So, there are efforts to use other measures, like the United Nations' Human Development Index (HDI), that focus on measuring social and environmental progress. The Happy Planet Index, made by the New Economics Foundation, and some countries have made their own, like the Gross National Happiness Index. (GNH).

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