The Determinants of Unemployment Rate: The Case of Thailand

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จุฬาลงกรณ์มหาวิทยาลัย
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วสมน โพธิ์ศรี : ปัจจัยกำหนดอัตราการว่างงาน กรณีประเทศไทย. (The Determinants of Unemployment Rate: The Case of Thailand) อ.ที่ปรึกษาหลัก : ผศ. ดร.นิพิฐ วงศ์ปัญญา

การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อวิเคราะห์ปัจจัยที่ส่งผลกระทบต่ออัตราการว่างงานในประเทศไทย ในระหว่างปี 2554 ถึง 2564 ประกอบด้วย อัตราเงินเฟ้อ อัตราการเติบโตทางเศรษฐกิจที่แท้จริง การสะสมเงินทุนถาวรที่แท้จริง การส่งออกสินค้าและบริการที่แท้จริง ตัวแปรหุ่นรายไตรมาส และตัวแปรหุ่นโควิด-19 ด้วยวิธีกำลังสองน้อยที่สุด (OLS) โดยใช้ข้อมูลอนุกรมเวลารายไตรมาส ระหว่างไตรมาสที่หนึ่ง ปี 2554 ถึงไตรมาสที่สาม ปี 2564 จากธนาคารแห่งประเทศไทย กระทรวงพาณิชย์ และสำนักงานสภาพัฒนาการเศรษฐกิจและสังคมแห่งชาติ ผลการศึกษาพบว่าตัวแปรต้นทั้งหมดส่งผลกระทบต่ออัตราการว่างงานถึง 59.2% โดยมีสามตัวแปรที่ส่งผลต่ออัตราการว่างงานอย่างมีนัยสำคัญ ได้แก่ อัตราเงินเฟ้อและการส่งออกสินค้าและบริการที่แท้จริง (ผลกระทบทางลบ) และตัวแปรหุ่นรายไตรมาส การพยากรณ์อัตราการว่างงานในไตรมาสที่สี่ ปี 2554 พบว่ามีค่าเท่ากับ 2.02% ในกรณีที่มีสถานการณ์โควิด-19 ซึ่งต่างจากกรณีที่ไม่มีสถานการณ์โควิด-19 ซึ่งมีค่าเท่ากับ 1.92% อยู่ 0.1% สำหรับผลการศึกษาปฏิสัมพันธ์ระหว่างอัตราการเติบโตทางเศรษฐกิจที่แท้จริงกับอัตราเงินเฟ้อพบว่า ทั้งสองตัวแปรมีปฏิสัมพันธ์ระหว่างกันโดยส่งผลกระทบต่ออัตราการว่างงาน 4.97% จากการวิเคราะห์ปฏิสัมพันธ์ระหว่างตัวแปรพบว่า ถ้าอัตราการเติบโตทางเศรษฐกิจที่แท้จริงเพิ่มขึ้น 1% โดยเฉลี่ย เส้นโค้งฟิลลิปส์ยังคงประยุกต์ใช้ได้ เมื่ออัตราเงินเฟ้อต่ำกว่า 0.65% และพบว่าถ้าอัตราการเติบโตทางเศรษฐกิจที่แท้จริงอยู่ในระดับต่ำหรือปานกลาง ยิ่งระดับอัตราเงินเฟ้อสูงขึ้น อัตราการว่างงานยิ่งลดลง ขณะที่ถ้าอัตราการเติบโตทางเศรษฐกิจที่แท้จริงอยู่ในระดับสูง ยิ่งระดับอัตราเงินเฟ้อสูงขึ้น อัตราการว่างงานยิ่งเพิ่มขึ้น

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สาขาวิชา	เศรษฐศาสตร์ธุรกิจและการจัดการ	ลายมือชื่อนิสิต ....
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KEYWORD: Unemployment rate, Inflation rate, Gross domestic product growth rate, Gross fixed capital formation, Exports of goods and services, COVID-19

Wasamon Posrie : The Determinants of Unemployment Rate: The Case of Thailand. Advisor: Asst. Prof. NIPIT WONGPUNYA, Ph.D.

This study aimed to analyze factors that affected the unemployment rate in Thailand during 2011 to 2021, including inflation rate, real GDP growth rate, real gross fixed capital formation, real exports of goods and services, the dummy variables of year quarters and the dummy variable of COVID-19 by utilizing ordinary least square (OLS) method on the quarterly time series data from Q1:2011 to Q3:2021 from BOT, MOC, and NESDC. The results revealed that the predictor variables significantly produced an effect on the unemployment rate up to 59.2%. Only three predictors produced significant effects on the unemployment rate: inflation rate and real exports of goods and services (negative effect), and the dummy variables of year quarters. The forecasted unemployment rate in Q4:2021 = 2.02% if COVID-19 was present, which was different by 0.1% in the case of the COVID-19 was not present (1.92%). There was an interaction between real GDP growth rate and inflation rate producing an effect on the unemployment rate by 4.97%. From the interaction term analysis, the result indicated that if the real GDP growth rate increased by 1%, on average, the Phillips curve holds only when the inflation rate is less than 0.65%. Moreover, if the real GDP growth rate was in the low or medium levels, the higher the inflation level, the unemployment rate would decrease, while if the real GDP growth rate was in the high level, the higher the inflation level, the unemployment rate would increase.

Field of Study:	Business and Managerial Economics	Student's Signature ....
Academic Year:	2021	Advisor's Signature ....

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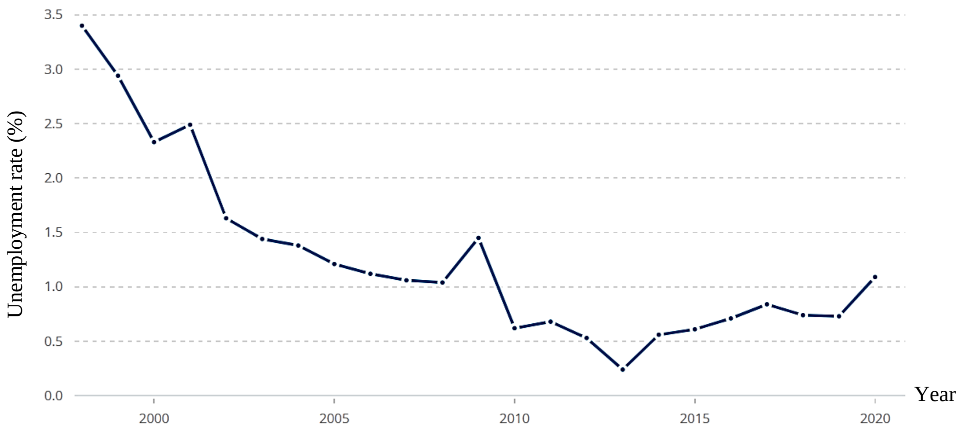
1. Introduction

The unemployment rate is well-known and widely used for labor market measures, which expresses a percentage of the labor force that cannot find a job. Moreover, an increasing unemployment rate has become one of the vital concerns for many countries worldwide since it negatively impacts economic growth. Therefore, the unemployment rate is an important indicator for the labor market and the economy in general.

Several factors that influence the unemployment rate have been identified, among which is the inflation rate. Mahmood et al. (2014) found that there was a significant negative effect between the unemployment rate and inflation rate in Pakistan during 1990 - 2010.

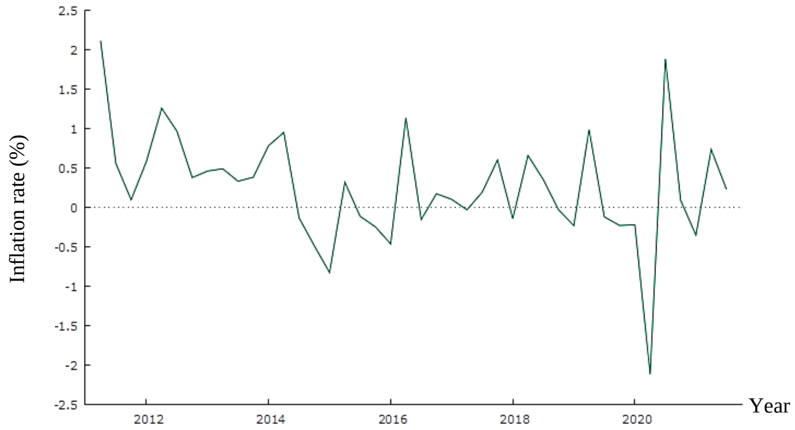
Figure 1: Thailand's unemployment rate during 1998 - 2020



Source: World Bank

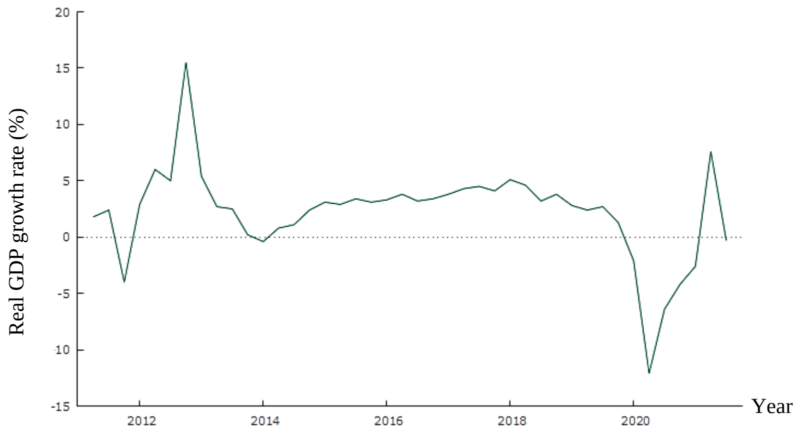
From the World Bank data in 2020, Thailand's unemployment rate was found to be among one of the lowest rankings in the world. However, Thailand has faced an increasing trend since 2013, from lower than 0.25 to around 1.1 percent in 2020. COVID-19 pandemic is one of the reasons that made Thailand have a higher unemployment rate since it began in Thailand in the first quarter of 2020 (WHO report). This study aimed to analyze the factors that affected the unemployment rate (UN) during 2011 to 2021, including inflation rate (INF), real gross domestic product growth rate (GDP), real gross fixed capital formation (GFCF), and real exports of goods and services (EX).

Figure 2: Thailand's inflation rate during Q1:2011 - Q3:2021



Source: Ministry of Commerce

Figure 3: Thailand's real GDP growth rate during Q1:2011 - Q3:2021



Source: Office of the National Economic and Social Development Council

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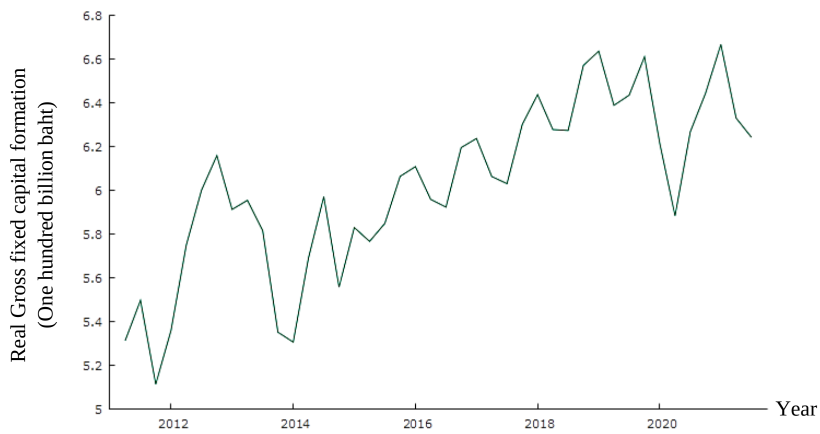
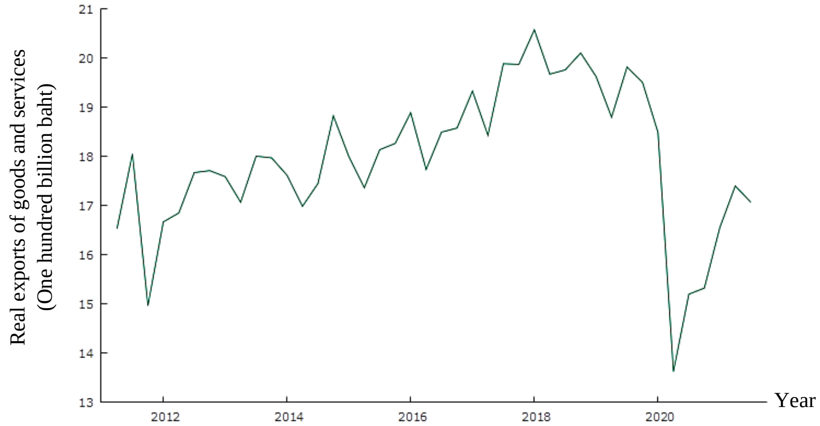
Figure 4: Thailand's real gross fixed capital formation during Q1:2011 - Q3:2021



Source: Office of the National Economic and Social Development Council

Figure 5: Thailand's real exports of goods and services during Q1:2011 - Q3:2021



Source: Office of the National Economic and Social Development Council

It can be seen from the graphs above that during Q1:2011 to Q3:2021, Thailand had a low inflation rate around the mean of 0.26 percent. The real gross domestic product growth rate dramatically dropped at Q2:2020 due to the beginning of COVID-19 pandemic in Thailand, while real gross fixed capital formation and real exports of goods and services showed an increasing trend.

There are four main research questions in this study as follow:

1. How much do all the predictors in the model: inflation rate, real GDP growth rate, real gross fixed capital formation, real exports of goods and services, the dummy variables of year quarters and the dummy variable of COVID-19 produce an effect on the unemployment rate?
2. How much does each predictor in the model: inflation rate, real GDP growth rate, real gross fixed capital formation, real exports of goods and services, the dummy variables of year quarters and the dummy variable of COVID-19 produce an effect on the unemployment rate?
3. What are the forecasted unemployment rate in Q4 of 2021 in case that the COVID-19 is present and not present? and How are they different?
4. Do the real GDP growth rate and inflation rate interact? How do they interact? and How much does the interaction affect the unemployment rate?

This study was divided into five sectors. The second section summarized the literature review. The third section presented conceptual framework, methodology, and data collection. Section fourth dealt with data analysis and results. conclusion, discussion, limitation, and suggestion were in section five of the paper.

2. Literature review

According to various theories and studies, unemployment rate and macroeconomic variables are linked.

Phillips curve (William Phillips, 1958) is one of the essential theoretical connections that provides a negative relationship between inflation and unemployment. The theory was put in place by the Friedman-Phelps natural rate model revealing that it was only applicable in the shot-run. Similar to Alisa (2015) who analyzed the relationship between both variables in Russia. Her result revealed that the inverse relationship between inflation and unemployment held in the short-run. However, in the long-run, the relationship was absent. In addition, she also concluded that maintaining a stable market required a certain amount of inflation and unemployment. However, the theory was not entirely applicable in Russian today's economy. In Turkey, Doğan (2012) investigated the effects of macroeconomic shocks on the unemployment rate by applying the vector autoregressive (VAR) model. He found that the unemployment rate significantly decreased when there were positive shocks to the inflation rate, which was generally in line with Yüksel and Adalı (2017) conducted a study by the multivariate adaptive regression splines (MARS) method found that if inflation was less than 10.338, then there was an inverse relationship between the unemployment rate and inflation. However, it did not affect the unemployment rate when it was more than 10.338. In Pakistan, Arslan and Zaman (2014), Mahmood et al. (2014), and Azhar et al. (2019) conducted the studies using the ordinary least square (OLS) model, forward & backward stepwise regression, and the Johansen cointegration test & Vector Error Correction technique. They found the same conclusion that there was a significant negative effect between the unemployment rate and inflation. Likewise, Khumalo and Eita (2015) conducted a study in Swaziland by applying the Engle-Granger two-step econometric technique. They found a negative effect between both variables even though it was not significant. In contrast, there were studies showing a significant positive effect between both variables. For example, In Bangladesh, Chowdhury and Hossain (2014) utilized a simple single equation linear regression model (SELRM), In China, Chang (2005) applied the autoregressive distributed lag (ARDL) approach and In Bahrain, Alrayes and Abu Wadi (2018) used the ordinary least square (OLS) model. Furthermore, Olanrewaju (2019) examined the effect of real exchange rate and inflation interaction on unemployment in Nigeria by employing the generalized method of moments (GMM) technique in order to control the endogeneity of variables found that the higher the inflation rate and real exchange rate depreciation, the unemployment increased.

Okun's law (Arthur Okun, 1962) is also another essential theoretical connection that establishes a link between economic growth and employment. His original work states that to avoid the waste of unemployment, an economy must continually expand as the unemployment rate falls by 1 percent, the economic growth will rise by approximately 3 percent. The existence of Okun's law was confirmed by Azhar et al. (2019) study in Pakistan, which found that 2 percent increase in economic growth may reduce unemployment by 1 percent in the short-run. Arslan and Zaman (2014) conducted a study in Pakistan and found that the gross domestic product growth rate had a negative effect on unemployment, which was in accordance with the results of the studies in Turkey from Doğan (2012) and Yüksel and Adalı (2017). Similarly, Chowdhury and Hossain (2014) determined macroeconomic determinants of the unemployment rate in Bangladesh by applying a simple single equation linear regression model (SELRM) found the same result. In addition, Chang (2005) conducting a study in China found that the gross domestic growth rate and population negatively significantly affected the unemployment rate proving that there was a long-run relationship between them, which was generally in line with the study in Swaziland by Khumalo and Eita (2015) finding that both gross domestic product and inflation had a negative relationship with the unemployment rate and there was a long-term relationship between unemployment rate and the determinants. Meanwhile, Alrayes and Abu Wadi (2018) and Dorcas et al. (2018), studied the determinants of the unemployment rate in Bahrain and Nigeria, also found the negative impact between both variables but the results were not significant. Furthermore, Meyer and Sanusi (2019) examined the causality between economic growth, gross fixed capital formation, and employment in South Africa by using the Johansen cointegration and vector error correction models (VECM). Their results revealed that there was a long-run relationship between the variables. The investment positively affected employment. In the long-run, economic growth was an essential driver of investment, employment, and export even if the relationship between economic growth and job creation was bi-directional causality.

Gross fixed capital formation and Export have been recognized as essential components to facilitate economic growth and employment. Theoretically, an increase in investment is expected to provide more jobs. The study in Bahrain by Alrayes and Abu Wadi (2018) was in line with this conclusion. Moreover, Azhar et al. (2019) explored the macroeconomic determinants of the unemployment rate in Pakistan and found that gross fixed capital formation had no significant relationship with unemployment in the long-run but it had a negative significant relationship in the short-run, similar to Meyer and Sanusi (2019). In contrast, Dorcas et al. (2018) analyzed the impact of the macroeconomics of Nigeria on the unemployment rate found that the unemployment rate was positively related to gross fixed capital formation and import. Ugarte and Olarreaga (2021) researched the impact of export promotion on aggregate unemployment. This paper focused on how the Export Promotion Agencies (EPAs) affected aggregate unemployment. The main data and source were the aggregate unemployment from the International Labour Organization (ILO), covering 96 countries over 1995 to 2009. They found that increasing the share of EPAs budgets on total exports, which the country had a comparative advantage, leading to small decreases in aggregate unemployment. On the other hand, aggregate unemployment increased when the EPAs tried to reduce aggregate unemployment by focusing their effort on sectors with high unemployment levels, which was generally in accordance with Dorcas et al. (2018) study, finding that unemployment was negatively related to export.

Lastly, Svabova et al. (2021) evaluated the impact of the COVID-19 pandemic on the unemployment rate in Slovakia based on the counterfactual method of before-after comparison during 2013 to 2020. As in the first quarter of 2020, the COVID-pandemic first appeared in the world, they assumed a counterfactual situation of no pandemic compared with the actual situation during 2020. The result indicated that during 2020, the unemployment rate increased by 2-3 percent compared to its development trend without a pandemic.

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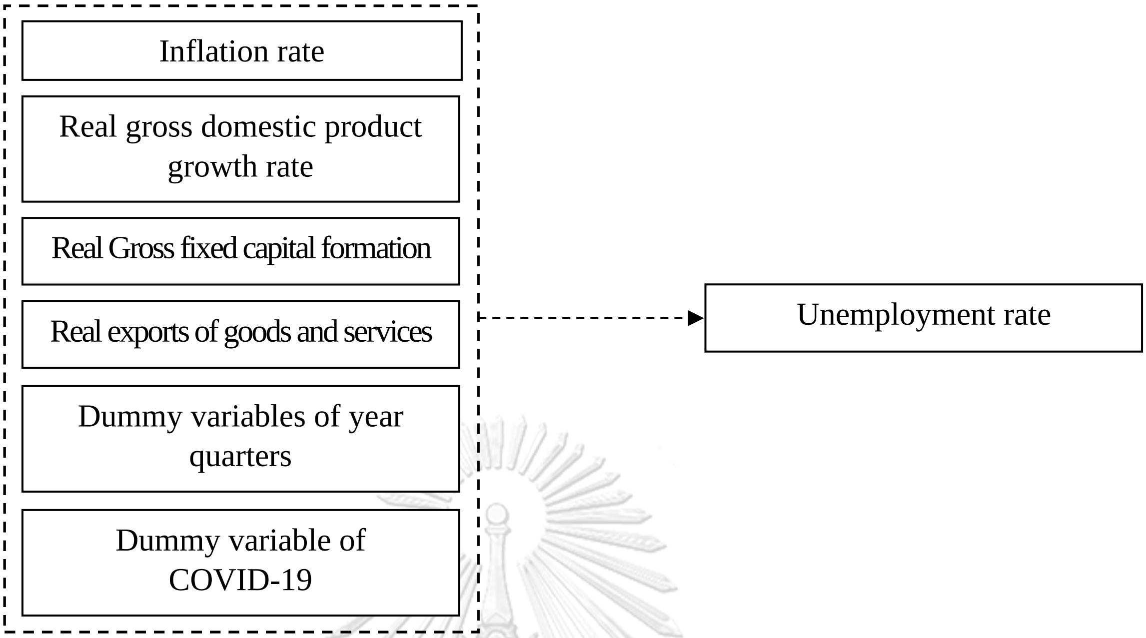
3. Conceptual Framework, Methodology, and Data Collection

3.1 Conceptual framework

The conceptual framework as shown in Figure 6 consists of six explanatory variables. Inflation rate (INF) and real gross domestic product growth rate (GDP) are based on the Phillips curve and Okun's law. Real gross fixed capital formation (GFCF) and real exports of goods and services (EX) are included as they have been identified for their effect on unemployment rate from various studies. Dummy variables of year quarters (DQ1, DQ2, DQ3) are included to remove the seasonal factor from a time series data. Last, Dummy variable of COVID-19 (DCOVID) is included as there was COVID-19 during the analysis period.

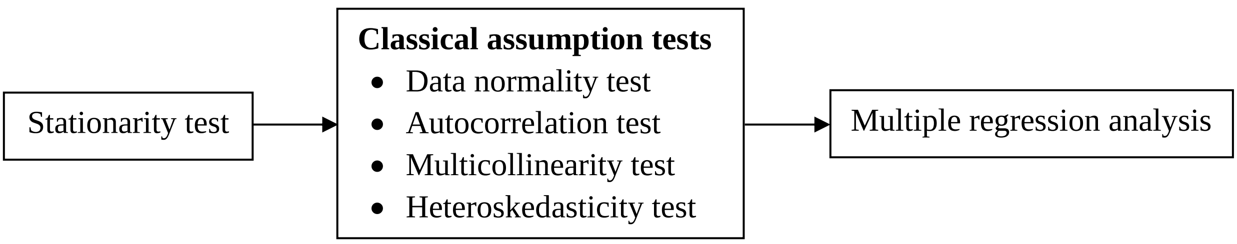
Figure 6: Conceptual framework



3.2 Methodology

The flow chart of methodology as shown in Figure 7 illustrates the procedure that uses in this paper. The procedure begins with a stationary test by using the Augmented Dickey-Fuller tests and follows by the classical assumption tests, as (Gujarati & Porter, 2009) suggests that if the multiple regression model meets BLUE criteria (Best Linear Unbiased Estimator), it is a good model. If all the assumptions pass the tests, then multiple regression analysis is employed.

Figure 7: Methodology flowchart



3.2.1) Multiple regression analysis

Many researchers used ordinary least squares (OLS) method to determine the macroeconomic variables affecting the unemployment rate. Therefore, this study utilizes the method to estimate the relationship of how inflation rate, real gross domestic product growth rate, and other factors affected Thailand's unemployment rate from Q1:2011 to Q3:2021. Thus, the model function can be summarized as follows:

$$\begin{array}{l} \text{UN} = \text{F(INF, GDP, GFCF, EX, DQ1, DQ2, DQ3, DCOVID)} \\ \qquad\qquad\quad (-) \quad (-) \quad\;\; (-) \quad\; (-) \qquad\qquad\qquad\qquad\qquad\quad (+) \end{array}$$

On the left side of the model is a dependent variable which is unemployment rate (UN). The independent variables on the right side consist of eight variables.

First is the inflation rate (INF), this variable has a negative relationship to UN based on the economic theory, Phillip Curve, which implies that as inflation increases, unemployment decreases. However, the Phillips curve is applicable only in the short run (Alisa, 2015).

Second, the real gross domestic product growth rate (GDP) has a negative relationship with UN based on Okun's law, which implies that as unemployment rate increases, it associates with negative growth in real GDP.

The real gross fixed capital formation (GFCF) is the third independent variable in the model, it has a negative relationship with unemployment rate (Alrayes & Abu Wadi, 2018).

Fourth, the real exports of goods and services (EX) also has a negative relationship with UN because employment rises due to increased exports (Doğan, 2012).

Fifth, DQ1, DQ2 and DQ3 are dummy variables for quarter one to quarter three which will remove the seasonal factor from a time series data allowing us to focus on the other time series components (Gujarati & Porter, 2009). They defined as follows:

DQ1 = 1, if quarter 1, 0 otherwise
DQ2 = 1, if quarter 2, 0 otherwise
DQ3 = 1, if quarter 3, 0 otherwise

The fourth quarter dummy variable has been omitted to avoid dummy variable trap which will cause the regression to fail.

Last, DCOVID is also a dummy variable. DCOVD = 1, if there is COVID-19 during the period, 0 otherwise. Then if there is COVID-19 during the period, the unemployment rate will increase, which is confirmed by (Svabova et al., 2021) that during the pandemic, the unemployment rate in Slovakia went up by 2-3 percent, compared to its development trend without a pandemic.

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Then the regression model is as follows:

$$UN_t = \beta_1 + \beta_2 INF_t + \beta_3 GDP_t + \beta_4 GFCF_t + \beta_5 EX_t + \beta_6 DQ1_t + \beta_7 DQ2_t + \beta_8 DQ3_t + \beta_9 DCOVID_t + \varepsilon_t \tag{1}$$

Where:

β_1 = a constant

β_2 to β_9 = coefficients

ε_t = an error term

3.2.2) Analysis of variance of regression

Analysis of variance of regression (ANOVAR) is employed to test if the regression slope coefficient β_j are equal to zero or not through the F-test of MSR/MSE (Huitema, 2011).

The statistical hypotheses of the test are:

H_0: $\beta_1 = \beta_2 \ldots = \beta_j = 0$

H_a: $\beta_1 \neq \beta_2 \ldots \neq \beta_j \neq 0$

If the test is significant with the condition that p-value $\leq \alpha$, the null hypothesis is rejected, meaning that the independent variables have a significant effect on the dependent variable. Since both β_j and R^2 represent the effect of the independent variables on the dependent variable, the null hypothesis H_0: $\beta_1 = \beta_2 \ldots = \beta_j = 0$ and H_0: $R^2 = 0$ refer to the same thing. The test of H_0: $\beta_1 = 0$ is the same as the test of H_0: $R^2 = 0$.

When we conduct the regression analysis through the SPSS program, the program will give the model summary table with R-square and the analysis of regression table to test if the R-square is significant, as shown in the figure below.

Figure 8: The SPSS sample result

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.769[a]	.592	.493	.14377	2.485

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.990	8	.124	5.988	.000[a]
	Residual	.682	33	.021		
	Total	1.672	41			

a. Predictors: (Constant), DCOVID, DQ3, INF, GFCF0, DQ1, DQ2, GDPG, EX0_1

b. Dependent Variable: UN1

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3.2.3) Stationarity test

Stationarity is the property of the data that the value of the variable does not change with time, which can be detected from a graph. If the data is not affected by time, the graph will not show an upward or downward trend. However, mathematical proof is also necessary. Augmented Dickey-Fuller tests is frequently used since it accounts for serial correlation in time series.

The statistical hypotheses of the test are:

H_0: the variable has unit root.

H_a: the variable has no unit root.

The ADF test for unit root in a time series y can be estimated as the following equation:

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{\rho} \beta_i \Delta y_{t-i} + \varepsilon_t$$

Where:

Δ = first difference operator

ρ = lag operator

t = time subscript

ε_t = the error term

There are three forms of the ADF test as follows:

1. Without intercept and trend

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{\rho} \beta_i \Delta y + \varepsilon_t$$

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2. With intercept

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{\rho} \beta_i \Delta y + \varepsilon_t$$

3. With intercept and trend

$$\Delta y_t = \alpha_0 + \gamma y + \beta t + \sum_{i=1}^{\rho} \beta_i \Delta y_{t-i} + \varepsilon_t$$

If the p-value > 0.05, we fail to reject the null hypothesis, meaning that the time series is non-stationary.

If the p-value ≤ 0.05, we reject the null hypothesis, meaning that the time series is stationary.

3.2.4) Data normality test

The normality of data can be observed by plotting histogram. However, sometimes it is not so obvious to detect visually. So, the Jarque-Bera test is supplementary to the graphical assessment of normality.

The statistical hypotheses of the test are:

H_0: the sample is normally distributed.

H_a: the sample is non-normally distributed.

The test statistic can be calculated by the formula as follows:

$$JB = \frac{n}{6}\left(S^2 + \frac{(K-3)^2}{4}\right)$$

Where:

S = the sample skewness

K = the sample kurtosis

n = the sample size

If the $p > 0.05$, we fail to reject the null hypothesis, meaning that the sample is normally distributed.

If the $p \leq 0.05$, we reject the null hypothesis, meaning that the sample is not normally distributed.

3.2.5) Autocorrelation test

Autocorrelation is a common problem of regression involving time series, leading to underestimating the standard error and causing the incorrect p-value of explanatory variables, which can be detected by the Durbin-Watson test.

The statistical hypotheses of the test are:

H_0: no first order autocorrelation.

H_a: first order correlation exists.

The assumptions of the test are:

The errors are stationary and normally distributed with a mean of zero.

The test statistic can be calculated by the formula as follows:

$$d = \frac{\sum_{t=2}^{n}(e_t - e_{t-1})^2}{\sum_{t=1}^{n} {e_t}^2}$$

Where:

e_t = residuals from the regression

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The test statistic from the Durbin-Watson test ranges between zero and four. If the test statistic is smaller than one or greater than three it indicates that an autocorrelation has occurred. If it is not, there is no autocorrelation in the model (Field, 2009).

3.2.6) Multicollinearity test

When two or more explanatory variables have a moderate or high correlation in a regression model, multicollinearity is present.

Multicollinearity can be detected by looking at correlations only among pairs of explanatory variables, however it is limiting as there is a possibility that the correlations between two variables are small, but a linear relationship exists between three or more. So, variance inflation factors (VIF) are frequently used by regression analysts to detect multicollinearity, which can be calculated by the formula as follows:

$$\mathrm{VIF_i} = \frac{1}{(1 - \mathrm{R_i^2})}$$

Where $\mathrm{R_i^2}$ = the unadjusted coefficient of determination for regressing the i^{th} independent variable on the remaining ones.

The maximum of VIF allowed is ten (Gujarati & Porter, 2009). If VIF is higher than ten, then there is significant multicollinearity that needs to be corrected.

3.2.7) Heteroscedasticity test

The heteroscedasticity can be observed by a scatterplot graph between residuals and predicted value. If it creates a cone shape pattern, the cone shape can be in either direction, left to right or right to left, then heteroscedasticity is present in the model because increasing the predicted values lead to increasing the residuals. If it is not, then heteroscedasticity is not present in the model.

Furthermore, the presence of heteroscedasticity can be detected by White's test. The hypotheses of the test are:

H_0: $\sigma_i^2 = \sigma^2$

H_a: $\sigma_i^2 \neq \sigma^2$

If the $p > 0.05$, we fail to reject the null hypothesis, meaning that heteroscedasticity is not present in the model.

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If the p < 0.05, we reject the null hypothesis, meaning that heteroscedasticity is present in the model.

3.2.8) Interaction

Interaction is an interplay among predictors that produces an effect on the outcome Y that is different from the sum of the effect of the individual predictors (Cohen et al., 2014).

The regression equation is:

$$Y = \beta_0 + \beta_1(X_1) + \beta_2(X_2) + \varepsilon$$

The regression equation with an interaction is:

$$Y = \beta_0 + \beta_1(X_1) + \beta_2(X_2) + \beta_3(X_1X_2) + \varepsilon$$

Where:

X_1X_2 = the interaction between X_1 and X_2

β_3 = the regression coefficient of the interaction variable (X_1X_2)

Assuming X_1X_2 has a significant interaction effect. For an easier explanation, we reconstruct the equation as follows:

$$\hat{Y} = (\beta_0 + \beta_2(X2) + ((\beta_1 + \beta_3(X_2))X_1)$$

Where:

The ($\beta_0 + \beta_2(X_2)$) term = the simple intercept

The (($\beta_1 + \beta_3(X_2)X_1$) term = the simple slope

The example coefficients in this analysis are conducted by (Aiken et al., 1991)

$$Y = 90.15 - 24.68(X_1) - 9.33(X_2) + 2.58(X_1X_2) + \varepsilon$$

$$\hat{Y} = (90.15 - 9.33(X_2)) + (-24.68 + 2.58(X_2))X_1$$

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To examine the interaction, The values of X_2 must be chosen to compute simple slopes and it should stay within the observed range of X_2 which researchers usually choose the mean of X_2 minus one S.D. of X_2, the mean of X_2 and the mean of X_2 plus one S.D. of X_2.

Given:

Mean of X_2 = 10

S.D. of X_2 = 2.2

Then:

X_2low = 10 – 2.2 = 7.8

X_2medium = 10

X_2high = 10 + 2.2 = 12.2

So:

X_2low line:

$= (90.15 - 9.33(7.8)) + (-24.68 + 2.58(7.8))X_1$

$= 17.38 + (-4.56(X_1))$

X_2medium line:

$= (90.15 - 9.33(10)) + (-24.68 + 2.58(10))X_1$

$= -3.15 + 1.12(X_1)$

X_2high line:

$= (90.15 - 9.33(12.2)) + (-24.68 + 2.58(12.2))X_1$

$= -23.68 + 6.8(X_1)$

For the value of X_1, we should choose the value that stay within the observed range of X_1. Then plot a line graph which each line in the plot will correspond to a chosen level of X_2.

3.3 Data collection

To conduct this research, we used time series data on quarterly basis from Q1:2011 to Q3:2021 from three public available sources. Unemployment rate (UN) was gathered from the Bank of Thailand (BOT). The data of real gross domestic product growth rate (GDP), real gross fixed capital formation (GFCF), and real exports of goods and services (EX) were obtained from the Office of the National Economic and Social Development Council (NESDC), while the inflation rate (INF) was gathered from the Ministry of Commerce (MOC). Therefore, the data collection was summarized and explained in table 1 as follows:

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Table 1: Summary of data collection

Variable Type	Symbol	Description	Reference year	Unit	Sign	Source
Dependent variable	UN	Unemployment rate	-	Percent	-	BOT
Independent variable	INF	Inflation rate	2019	Percent	Negative	MOC
Independent variable	GDP	Real gross domestic product growth rare	2002	Percent	Negative	NESDC
Independent variable	GFCF	Real gross fixed capital formation	2002	One hundred billion baht	Negative	NESDC

Table 1: Summary of data collection (continued)

Variable Type	Symbol	Description	Reference year	Unit	Sign	Source
Independent variable	EX	Real exports of goods and services	2002	One hundred billion baht	Negative	NESDC
Independent variable (Dummy)	DQ1	Dummy variable for Quarter 1 1 = if quarter 1 0 = otherwise	-	-	-	-
Independent variable (Dummy)	DQ2	Dummy variable for Quarter 2 1 = if quarter 2 0 = otherwise	-	-	-	-
Independent variable (Dummy)	DQ3	Dummy variable for Quarter 3 1 = if quarter 3 0 = otherwise	-	-	-	-
Independent variable (Dummy)	DCOVID	Dummy variable for COVID-19 1 = there is COVID-19 during the period 0 = otherwise	-	-	Positive	WHO

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4. Data Analysis and Results

4.1 Data manipulation

4.1.1) Stationarity test

Graphical analysis was first performed (see Appendix), and it was concluded that the UN and EX were stationary at first difference. But it was necessary to prove it with the Augmented Dickey-Fuller tests mathematically. Therefore, the summary of the ADF unit root test was presented in table 2 as follows:

Table 2: Summary of the ADF unit root test results

Variables	**t-statistic**	**p-value**	**Stability Degree**
UN	-7.120	0.00	I(1)
INF	-6.265	0.00	I(0)
GDP	-3.468	0.01	I(0)
GFCF	-4.143	0.01	I(0)
EX	-8.405	0.00	I(1)

The result of the ADF unit root test suggested that all variables except INF, GDP, and GFCF were non-stationary as they failed to reject the null hypothesis at 5 percent level of significance. However, after the first difference was executed, they became stationary.

Then the regression model are as follows:

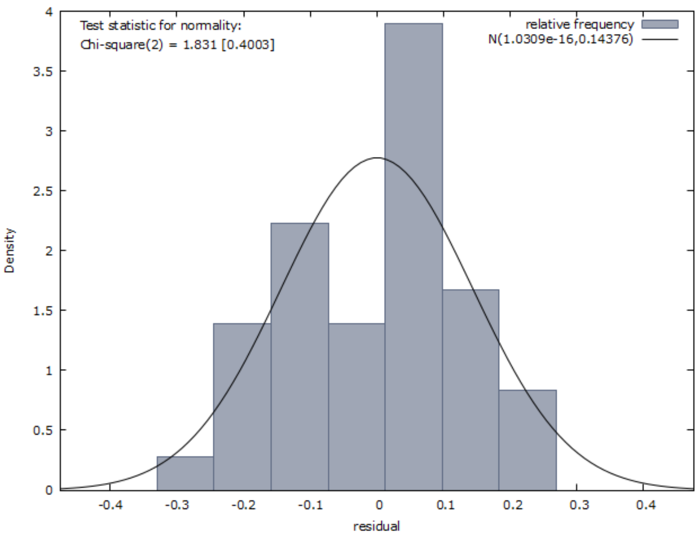
$$UN1_t = \beta_1 + \beta_2 INF_t + \beta_3 GDP_t + \beta_4 GFCF_t + \beta_5 EX1_t + \beta_6 DQ1_t + \beta_7 DQ2_t + \beta_8 DQ3_t + \beta_9 DCOVID_t + \varepsilon_t \quad (2)$$

4.2 Classical assumption tests

4.2.1) Data normality test

The histogram was utilized to check the normality assumption as shown in the following figure.

Figure 9: The model histogram



From figure 9, it can be seen that the UN1 sample data was approximately normal, which corroborated by the result of Jarque-Bera test in table 3 as follows:

Table 3: The Jarque-Bera test result

Model	test statistic	p-value
1	1.831	0.40

From table 3, the test statistic was 1.831, with a p-value of 0.4, meaning that we failed to reject the null hypothesis. Therefore, the data was normally distributed in this scenario.

4.2.2) Autocorrelation test

The Durbin-Watson test was performed to detect the autocorrelation. The result of the Durbin-Watson test was shown in table 4 as follows:

Table 4: The Durbin-Watson test result

Model	Durbin-Watson
1	2.485

The value of Durbin-Watson statistic was 2.485 which was between 1 and 3, meaning that there was no autocorrelation of errors in the model.

4.2.3) Multicollinearity test

To check for the multicollinearity, the variance inflation factors (VIF) was performed. The result of VIF was shown in table 5 as follows:

Table 5: Summary of the variance inflation factors (VIF)

Model	Variables	VIF
1	INF	1.661
	GDP	2.250
	GFCF	1.420
	EX1	2.476
	DQ1	1.598
	DQ2	2.070
	DQ3	1.839
	DCOVID	1.913

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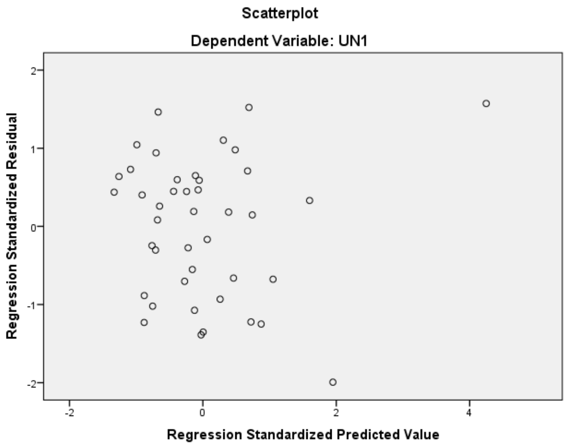
From table 5, it could be seen that VIFs of all independent variables were less than 10 meaning that there is no significant multicollinearity that needed to be correct.

4.2.4) Heteroskedasticity test

To check for the heteroscedasticity, the residual plot of predicted values and standardized residuals was conducted as shown in the following figure.

Figure 10: The residual plot



From figure 10, it appeared that the order paired dots did not form a cone shape pattern. So, it could be concluded that the model did not have the heteroskedasticity problem.

Table 6: The White's test result

Model	test statistic (LM)	p-value
1	37.735	0.39

To confirm the result of the residual plot, White's test was performed. The result of White's test was shown in table 6, the test statistic (LM) = 37.735 with $p = 0.39$. As the p-value was greater than 0.05, we failed to reject the null hypothesis, meaning that heteroscedasticity did not occur in the model.

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4.3 Descriptive statistics

Table 7: The summary of descriptive statistics

Variables	Mean	S.D.	Min	Max	Obs.
Dependent Variable					
UN1 (percent)	0.034	0.202	-0.28	0.92	42
Independent Variable					
INF (percent)	0.260	0.710	-2.11	2.11	42
GDP (percent)	2.214	4.144	-12.10	15.50	42
GFCF (One hundred billion baht)	6.018	0.392	5.11	6.67	42
EX1 (One hundred billion baht)	0.004	1.208	-4.86	1.71	42

The descriptive statistics from 42 observations were shown in table 7. The dependent variable, the change of unemployment rate (UN1), had the mean of 0.034 percent and S.D. of 0.202 percent with the minimum and maximum values of -0.28 percent and 0.92 percent respectively. The independent variables had the following means and S.Ds.: INF, mean = 0.26 percent, S.D. = 0.71 percent, GDP, mean = 2.214 percent, S.D. = 4.144 percent, GFCF, mean = 6.018 one hundred billion baht, S.D. = 0.392 one hundred billion baht, and EX1, mean = 0.004 one hundred billion baht, S.D. = 1.208 one hundred billion baht.

4.4 Results

There were four research questions in this study. The results of the study were shown according to each research question

1. How much do all the predictors in the model: inflation rate, real GDP growth rate, real gross fixed capital formation, real exports of goods and services, the dummy variables of year quarters and the dummy variable of COVID-19 produce an effect on the unemployment rate?

Table 8: The model summary

Model	R-square	Adjusted R-square
1	0.592	0.493

From table 8, it could be seen that the value of adjusted R-squared is 0.493, meaning that 49.3 percent of the variation in the UN1 was explained by all of independent variables in the model: INF, GDP, GFCF, EX1, DQ1, DQ2, DQ3 and DCOVID. The test of the significance of the R-square was shown in table 9.

Table 9: The analysis of variance of regression

Model		**Sum of squares**	**df**	**Mean square**	**F**	**p-value**	**R-square**
1	Regression	0.990	8	0.124	5.988	0.00	0.592
	Residual	0.682	33	0.021			
	Total	1.672	41				

From table 9, it could be seen that F = 5.988, $p = 0.00 < \alpha = 0.05$, meaning that the test of multiple R-square = 0.592 was significant.

All the independent variables included in the model were appropriate and had the significant effect on the dependent variable (UN1). The predictor variables explained the variance of the change of unemployment rate (UN1) up to 59.2 percent or the total effect of all the independent variables in the model on the UN1 was 59.2 percent (or 49.3 percent of the R-square adjusted).

2. How much does each predictor in the model: inflation rate, real GDP growth rate, real gross fixed capital formation, real exports of goods and services, the dummy variables of year quarters and the dummy variable of COVID-19 produce an effect on the unemployment rate?

The effect of each predictor variable on the dependent variable was shown through the semi-partial correlation square (Δ R-square). The Δ R-square, theoretically is the proportion or percent of the effect that each individual independent variable produces on the dependent variable, holding the other variables constant (Cohen et al., 2014).

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Table 10: The result of model 1

Model	**Variables**	**Coefficient**	**p-value**	**Semi-partial correlation (SR)**	**Δ R-square *100**
1	Intercept(constant)	0.194	0.64	-	-
	INF	-0.094	0.03	-0.255	6.50%
	GDP	-0.003	0.71	-0.042	0.18%
	GFCF	-0.046	0.51	-0.074	0.55%
	EX1	-0.059	0.05	-0.224	5.02%
	DQ1	0.238	0.00	0.401	16.08%
	DQ2	0.145	0.05	0.222	4.93%
	DQ3	0.131	0.06	0.213	4.54%
	DCOVID	0.102	0.22	0.138	1.90%

It could be seen from table 10 that the inflation rate (INF) and the change of real exports of goods and services (EX1) produced negative effects on the dependent variable (UN1) significantly at 0.05 ($p \leq 0.05$), while the other predictors except for some dummy variables were not significant ($p > 0.05$). According to the beta coefficient of -0.094, if the INF increases by one percent, the UN1 will decrease by 0.094 percent and based on the ΔR^2, the INF itself produced an effect on UN1 by 6.5 percent, holding the other variables constant. According to the beta coefficient of -0.059, the UN1 will decrease by 0.059 percent if the EX1 increases by one percent, holding the other variables constant. Based on the ΔR^2, the EX1 itself produced an effect on UN1 by 5.02 percent, holding the other variables constant. The other variables (GDP, GFCF and DCOVID) were not significant at the level of 0.05, however, the signs of regression coefficients met the expectation.

The effect of the dummy variables of year quarters (DQ1, DQ2, DQ3) can be calculated by running the regression full model and reduced model as shown in the table 11 and table 12.

Table 11: The regression full model

Model	R-square	Adjusted R-square
1	0.592	0.493
*Predictors: (Constant), INF, GDP, GFCF, EX1, DQ1, DQ2, DQ3, DCOVID		

Table 12: The regression reduced model

Model	R-square	Adjusted R-square
3	0.423	0.343
*Predictors: (Constant), INF, GDP, GFCF, EX1, DCOVID		

The effect of the dummy variables of year quarters can be calculated by subtracting the R-square of the reduced model from the full model, therefore, the effect of the dummy variables of year quarters or the $\Delta R^2 = 0.592 - 0.423 = 0.169$ or 16.9% and can test its significance as follows (Tate, 1998):

$$F = \frac{[\Delta R^2(x_h/x_r)]/h}{\left(1 - R_f^2\right)/(n-k-1)}$$

Where:

- h = the number of predictors needed to compute ΔR^2
- r = the rest of the predictors after reducing
- R_f^2 = R^2(full) of all the predictors in the model
- n = the sample size
- k = the number of all predictors

From the foregoing formula:

$$\Delta R^2(x_h/x_r) = 0.169$$
$$h = 3, R_f^2 = 0.592, n = 42, k = 8$$

Substituting all the values into the formula:

$$F = \frac{0.169/3}{(1 - 0.592)/(42 - 8 - 1)}$$
$$= \frac{0.056}{0.408/33} = \frac{0.056}{0.012}$$
$$= 4.67$$

From the F-distribution table $F_\alpha = F_{0.05,3,33} = 2.89$, $F = 4.67 > F_\alpha = 2.89$, therefore, the test is significant, the dummy variables of year quarters produced an effect of 16.9% on the dependent variable (UN1) significantly at the level of 0.05.

To show only the effect of the dummy variables of year quarters on the UN1, the following equation from table 10 was performed, under the assumption that the other variables were held constant.

UN1 = 0.194 + (0.238 x DQ1) + (0.145 x DQ2) + (0.131 x DQ3)

Therefore, the effect of each quarter on the UN1 will be showed as follows:

For quarter 1: DQ1 = 1, DQ2 = 0, DQ3 = 0
UN1 = 0.194 + (0.238 x 1) + (0.145 x 0) + (0.131 x 0) = 0.432

For quarter 2: DQ1 = 0, DQ2 = 1, DQ3 = 0
UN1 = 0.194 + (0.238 x 0) + (0.145 x 1) + (0.131 x 0) = 0.339

For quarter 3: DQ1 = 0, DQ2 = 0, DQ3 = 1
UN1 = 0.194 + (0.238 x 0) + (0.145 x 0) + (0.131 x 1) = 0.325

For quarter 4: DQ1 = 0, DQ2 = 0, DQ3 = 0
UN1 = 0.194 + (0.238 x 0) + (0.145 x 0) + (0.131 x 0) = 0.194

The results above showed that quarter 1 had the highest effect on the UN1 followed by quarter 2, quarter 3, and quarter 4, respectively.

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3. What are the forecasted unemployment rate in Q4 of 2021 in case that the COVID-19 is present and not present? and How are they different?

From the regression model (2):

$$UN1_t = \beta_1 + \beta_2 INF_t + \beta_3 GDP_t + \beta_4 GFCF_t + \beta_5 EX1_t + \beta_6 DQ1_t + \beta_7 DQ2_t + \beta_8 DQ3_t + \beta_9 DCOVID_t + \varepsilon_t$$

Substituting all the regression coefficients from table 10 into the model:

$$\widehat{UN1}_t = 0.194 + (-0.094) \text{ x } (INF_t) + (-0.003) \text{ x } (GDP_t) + (-0.046) \text{ x } (GFCF_t) + (-0.059) \text{ x } (EX1_t) + (0.238) \text{ x } (DQ1_t) + (0.145) \text{ x } (DQ2_t) + (0.131) \text{ x } (DQ3_t) + (0.102) \text{ x } (DCOVID_t)$$

Given the value for each independent variable at time t, Q4:2021 as follows:

INF = 1.796, GDP = 1.9, GFCF = 6.439, EX1 = 0.914, DQ1 = 0, DQ2 = 0, DQ3 = 0, and the value of UN at time t-1, Q3:2021 = 2.25

Substituting all the given value above into the model:

$$\widehat{UN1}_{Q4:2021} = 0.194 + (-0.094 \text{ x } 1.796) + (-0.003 \text{ x } 1.9) + (-0.046 \text{ x } 6.439) + (-0.059 \text{ x } 0.914) + (0.238 \text{ x } 0) + (0.145 \text{ x } 0) + (0.131 \text{ x } 0) + (0.102 \text{ x } DCOVID_{Q4:2021})$$

$$\widehat{UN1}_{Q4:2021} = -0.331 + (0.102 \text{ x } DCOVID_{Q4:2021})$$

Since $UN1_t = UN_t - UN_{t-1}$

$UN_t = UN1_t + UN_{t-1}$

Therefore,

If DCOVID = 1:

$UN1_{Q4:2021} = -0.331 + (0.102 \text{ x } 1) = -0.229$ or $UN_{Q4:2021} = 2.02$ percent, meaning that as there was COVID-19 during this period, the forecasted $UN_{Q4:2021} = 2.02$ percent which was 76.83 percent correct and close to the $UN_{Q4:2021} = 1.64$.

If DCOVID = 0:

$UN1_{Q4:2021} = -0.331 + (0.102 \text{ x } 0) = -0.331$ or $UN_{2021:Q3} = 1.92$ percent, meaning that as there was no COVID-19 during this period, the forecasted $UN_{Q4:2021} = 1.92$ percent which decreased by 0.10 percent when compared to the forecasted $UN_{2021:Q3}$ with COVID-19.

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4. Do the real GDP growth rate and inflation rate interact? How do they interact? and How much does the interaction affect the unemployment rate?

The GDP is a real gross domestic product growth rate, and the INF is an inflation rate. These two predictors are very important factors in the study of the change of the unemployment rate (UN1). From table 10, it could be seen that INF was a significant factor ($p = 0.03$) that produced a negative effect on the UN1. Even though the GDP was not a significant factor ($p = 0.71$), it is interesting to find out if these two factors interacted and how they did interact. The following table showed the interaction of the two factors (GDPINF).

Table 13: The result of model 2

Model	**Variables**	**Coefficient**	**p-value**	**Semi-partial correlation (SR)**	**Δ R-square *100**
2	Intercept(constant)	-0.006	0.99	-	-
	INF	-0.056	0.20	-0.139	1.93%
	GDP	-0.009	0.29	-0.113	1.28%
	GFCF	-0.011	0.88	-0.017	0.03%
	EX1	-0.037	0.23	-0.131	1.72%
	DQ1	0.243	0.00	0.409	16.73%
	DQ2	0.087	0.25	0.124	1.54%
	DQ3	0.113	0.09	0.183	3.35%
	DCOVID	0.052	0.53	0.067	0.45%
	GDPINF	0.014	0.04	0.223	4.97%

From table 13, it can be seen that when the interaction variable (GDPINF) was added to the model, the p-values of other independent variables dropped. This phenomenon is common in regression analysis since the new variable (the interaction variable) correlates with the other independent variables and obscures the effect of such independent variables on the dependent variable (UN1). However, the interaction variable (GDPINF) itself was a significant factor ($p = 0.04$) that produced an effect on the dependent variable (UN1) up to 4.97%

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The interaction term between GDP and INF was analyzed by two methods as follows:

1) The interaction term analysis by employing partial derivative
From the table 13 the regression model is:

$$UN1_t = \beta_1 + \beta_2 INF_t + \beta_3 GDP_t + \beta_4 GFCF_t + \beta_5 EX1_t + \beta_6 DQ1_t + \beta_7 DQ2_t + \beta_8 DQ3_t + \beta_9 DCOVID_t + \beta_{10} GDPINF_t + \varepsilon_t$$

Substituting all the regression coefficients from table 13 into the model:

$$\widehat{UN1}_t = (-0.006) + (-0.056) \text{ x } (INF_t) + (-0.009) \text{ x } (GDP_t) + (-0.011) \text{ x } (GFCF_t) + (-0.037) \text{ x } (EX1_t) + (0.243) \text{ x } (DQ1_t) + (0.087) \text{ x } (DQ2_t) + (0.113) \text{ x } (DQ3_t) + (0.052) \text{ x } (DCOVID_t) + (0.014) \text{ x } (GDPINF_t)$$

It can be shown that the change in the UN1 response with a one-unit increase in GDP when other variables are held constant is:

$$\frac{\partial \widehat{UN1}_t}{\partial GDP_t} = \beta_3 + (\beta 10 \text{ x } INF_t)$$

$$\frac{\partial \widehat{UN1}_t}{\partial GDP_t} = (-0.009) + (0.014 \text{ x } INF_t)$$

Therefore,

if INF < 0.65 percent:

GDP increased by one percent, on average, associated with decreasing UN1 of ((-0.009 + (0.014 x INF_t)) percent

if INF ≥ 0.65 percent:

GDP increased by one percent, on average, associated with increasing UN1 of ((-0.009 + (0.014 x INF_t)) percent

2) The interaction term analysis by the level of GDP and INF

It can be seen from the following computation and the graphic presentation displaying how the two variables interacted.

2.1) The computation

In order to compare the change in UN1 according to the interaction of the two variables.

From table 13, To show only the interaction effect of the two predictors, INF, GDP, and their interaction, GDPINF, the following equation from table 13 was performed, under the assumption that the other variables were held constant.

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UN1 = (-0.006) + (-0.056 x INF) + (-0.009 x GDP) + (0.014 x GDPINF)

From table 7, we have:

Variables	Mean	SD
GDP	2.214	4.144
INF	0.260	0.710

The levels of Low, Medium and High of GDP and INF are determined with their means and standard deviations as follows:

Level	Formula	GDP	INF
Low	= Mean – SD	-1.930	-0.450
Medium	= Mean	2.214	0.260
High	= Mean + SD	6.358	0.970

From the equation above, let GDPG = -1.93 (low)

UN1 = -0.006 + (-0.056 x INF) + 0.017 + (-0.027 x INF)

If INF = -0.45 UN1 = 0.048

INF = 0.26 UN1 = -0.011

INF = 0.97 UN1 = -0.07

From the equation above, let GDPG = 2.214 (medium)

UN1 = -0.006 + (-0.056 x INF) + (-0.02) + (0.031 x INF)

If INF = -0.45 UN1 = -0.015

INF = 0.26 UN1 = -0.033

INF = 0.97 UN1 = -0.05

From the equation above, let GDPG = 6.358 (high)

UN1 = -0.006 + (-0.056 x INF) + (-0.057) + (0.089 x INF)

If INF = -0.45 UN1 = -0.078

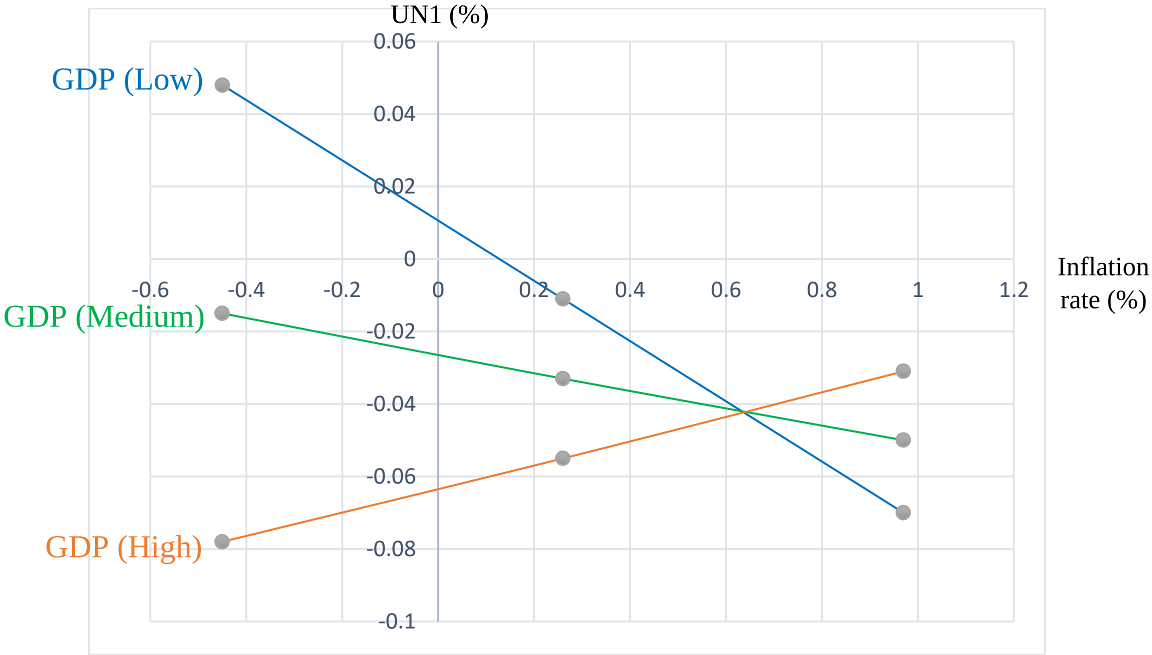
INF = 0.26 UN1 = -0.054

INF = 0.97 UN1 = -0.031

2.2) The graphic presentation

The interaction of the two variables: GDP and INF are shown in following figure.

Figure 11: The interaction between GDP and INF on UN1



From the Figure 5, it can be seen that the interaction of GDP and INF occurred as follows:

When GDP and INF were low (GDP= -1.93 and INF = -0.45), the UN1 increased by 0.048 percent.

When GDP was low (GDP = -1.93) and INF was high (INF = 0.97), the UN1 decreased by 0.070 percent.

When GDP was medium (GDP = 2.214) and INF was low (INF = -0.45), the UN1 decreased by 0.015 percent.

When GDP was medium (GDP = 2.214) and INF was high (INF = 0.97), the UN1 decreased by 0.050 percent.

When GDP was high (GDP = 6.358) and INF was low (INF = -0.45), the UN1 decreased by 0.078 percent.

When GDP was high (GDP = 6.358) and INF was high (INF = 0.97), the UN1 decreased by 0.031 percent.

5. Conclusion, Discussion, Limitation, and Suggestion

5.1 Conclusion

This study aimed to analyze factors that affected the unemployment rate (UN) in Thailand during 2011 to 2021, including inflation rate (INF), real gross domestic product growth rate (GDP), real gross fixed capital formation (GFCF), real exports of goods and services (EX), the dummy variables of year quarters (DQ1, DQ2 and DQ3) and the dummy variable of COVID-19 (DCOVID) by utilizing ordinary least square (OLS) method on the quarterly time series data from Q1:2011 to Q3:2021 from three public available sources.

There are four main research questions in this study as follow:

1. How much do all the predictors in the model: inflation rate, real GDP growth rate, real gross fixed capital formation, real exports of goods and services, the dummy variables of year quarters and the dummy variable of COVID-19 produce an effect on the unemployment rate?
2. How much does each predictor in the model: inflation rate, real GDP growth rate, real gross fixed capital formation, real exports of goods and services, the dummy variables of year quarters and the dummy variable of COVID-19 produce an effect on the unemployment rate?
3. What are the forecasted unemployment rate in Q4 of 2021 in case that the COVID-19 is present and not present? and How are they different?
4. Do the real GDP growth rate and inflation rate interact? How do they interact? and How much does the interaction affect the unemployment rate?

According to the first research question, the results revealed that the predictor variables significantly produced an effect on the change of unemployment rate (UN1) up to 59.2 percent.

For the second research question, the result showed that only three predictors produced significant effects on UN1, namely, INF (β = -0.094, ΔR^2 = 6.5 percent), EX1 (β = -0.059, ΔR^2 = 5.02 percent), and the dummy variables of year quarters: DQ1, DQ2, DQ3 (ΔR^2 = 16.9 percent).

For the third research question, the result showed that If the COVID-19 was present, the forecasted $UN_{Q4:2021}$ = 2.02 percent. On the other hand, if the COVID-19 was not present, the forecasted $UN_{Q4:2021}$ = 1.92 percent, which was different by 0.1 percent.

For the fourth research question, the study revealed that there was an interaction between GDP and INF producing an effect on the UN1 by 4.97 percent (ΔR^2 = 4.97 percent). For the interaction term analysis by employing

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partial derivative, the study showed that if GDP increases by one percent, on average, the Phillips curve holds only when INF is less than 0.65 percent. For the interaction term analysis by the level of GDP and INF, the result showed that if GDP was in the low or medium levels, the higher the inflation level, the UN1 would decrease. In contradiction, if GDP was in the high level, the higher the inflation level, the UN1 would increase.

5.2 Discussion

In this section, the results from each research question will be discussed and concluded.

According to the first research question, it was found that the predictor variables significantly produced an effect on the UN1 up to 59.2 percent, which was generally in line with Mahmood et al. (2014) and Dorcas et al. (2018) who conducted a study with the unemployment rate as a dependent variable, and predictor variables were inflation rate, gross domestic product, government final consumption, export, and import.

For the second research question, it was found that only three predictors produced significant effects on UN1, namely, INF (β = -0.094, ΔR^2 = 6.5 percent), EX1 (β = -0.059, ΔR^2 = 5.02 percent) and the dummy variables of year quarters: DQ1, DQ2, DQ3 (ΔR^2 = 16.9 percent). This finding was proven by most of the previous studies such as Doğan (2012), Arslan and Zaman (2014), Mahmood et al. (2014), and Azhar et al. (2019), who found that the inflation rate had a significant negative relationship with the unemployment rate. On top of that, it aligned with the Phillip curve as well. In terms of export, our finding was justified by the previous studies from Doğan (2012), Dorcas et al. (2018), and Ugarte and Olarreaga (2021), who found that the export also had the significant negative effect on the unemployment rate.

For the third research question, it was found that if the COVID-19 was present, the forecasted $UN_{Q4:2021}$ = 2.02 percent. On the other hand, if the COVID-19 was not present, the forecasted $UN_{Q4:2021}$ = 1.92 percent, which increased by 0.1 percent, in line with Svabova et al. (2021), who found that during 2020, the unemployment rate increased by 2-3 percent compared to the trend of Slovakia's unemployment rate without a pandemic.

For the last research question, it was found that there was an interaction between GDP and INF producing an effect on the UN1 by 4.97 percent (ΔR^2 = 4.97 percent). For the interaction term analysis by employing partial derivative, the study showed that if GDP increased by one percent, on average, the Phillips curve holds only when INF is less than 0.65 percent, which might be due to this study was conducted during the low inflation period (mean = 0.26 percent). The result was in accordance with Yüksel and Adalı (2017) study in Turkey, who found that if inflation was less than 10.338, then there was an inverse relationship between the unemployment rate and inflation. However, it did not affect the unemployment rate when it was more than 10.338. Similar to Alisa (2015) study, which showed that maintaining a stable labor market required a certain amount of inflation and unemployment. However, the Phillips curve is not entirely applicable in Russian today's economy. For the interaction term analysis by the level of GDP and INF, the result indicated that if GDP was in the low or medium levels, the higher the inflation level, the UN1 would decrease. In contradiction, if GDP was in the high level, the higher the inflation level, the UN1 would increase. According to my knowledge, there was no one conducting the same interaction with my study. However, Olanrewaju (2019) conducted a similar interaction between inflation rate and exchange rate on the unemployment rate in Nigeria and found that the higher the inflation rate and real exchange rate depreciation, the unemployment increased.

5.3 Limitation and Suggestion

1. The limitation of this study is the difficulty in obtaining the time series data on a quarterly basis as the public sources are mostly provided on a yearly basis.

2. In continuing this study, there should be more data, for example, the data that cover all COVID-19 period, and more predictor variables since if there are more data, it might lead to a better conclusion with more significant factors.

3. The interaction among predictor variables should be explored more in order to come up with a better conclusion in terms of economic theory and application.

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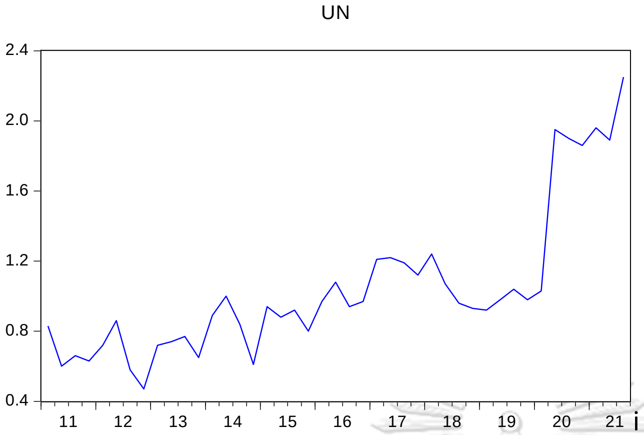
APPENDIX

Stationary test: The graphical analysis and ADF test result



Null Hypothesis: UN has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.222178	0.9275
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.

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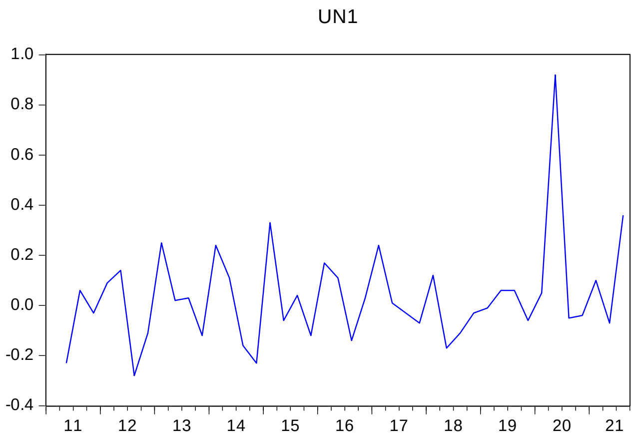
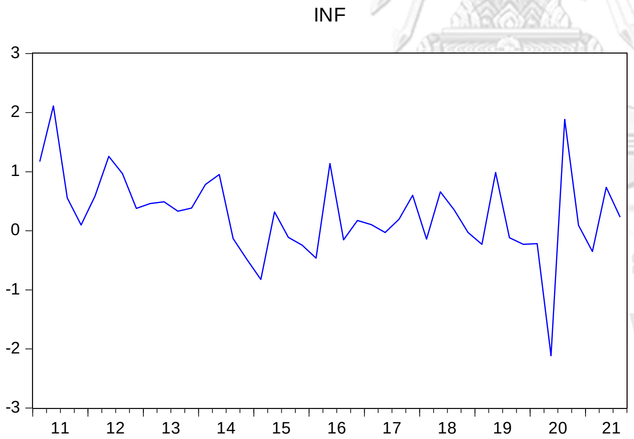


Null Hypothesis: D(UN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.120436	0.0000
Test critical values:	1% level	-3.600987	
	5% level	-2.935001	
	10% level	-2.605836	

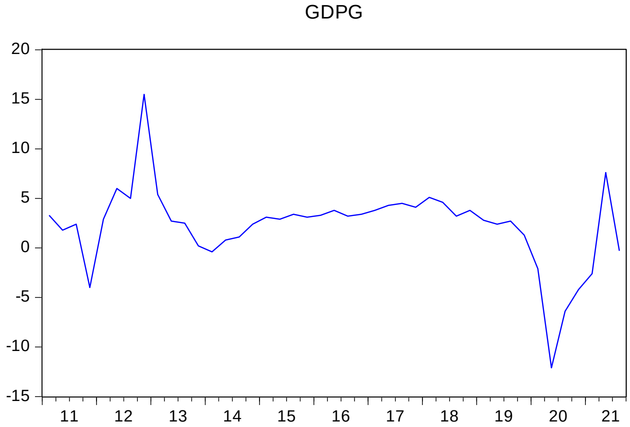
*MacKinnon (1996) one-sided -values.



Null Hypothesis: INF has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.264811	0.0000
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

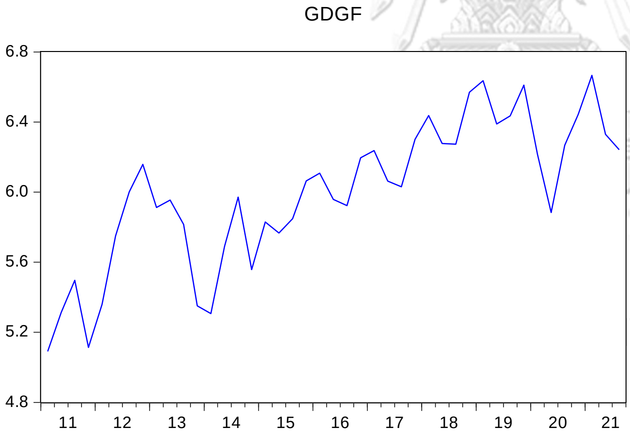
*MacKinnon (1996) one-sided p-values.



Null Hypothesis: GDPG has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.467975	0.0139
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

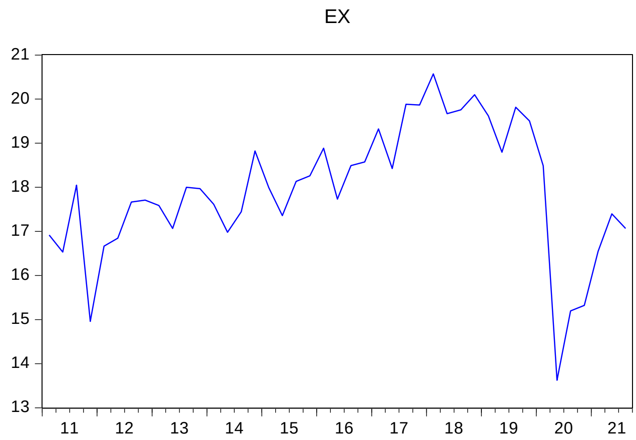
*MacKinnon (1996) one-sided p-values.



Null Hypothesis: GDGF has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.142725	0.0115
Test critical values:	1% level	-4.198503	
	5% level	-3.523623	
	10% level	-3.192902	

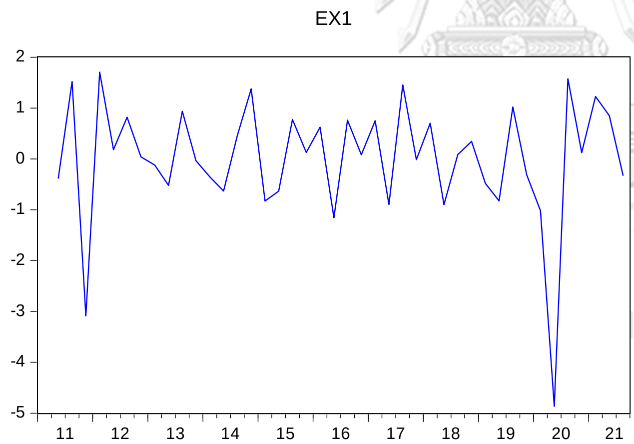
*MacKinnon (1996) one-sided p-values.



Null Hypothesis: EX has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.724483	0.2325
Test critical values:	1% level	-4.192337	
	5% level	-3.520787	
	10% level	-3.191277	

*MacKinnon (1996) one-sided p-values.



Null Hypothesis: D(EX) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.405498	0.0000
Test critical values:	1% level	-3.600987	
	5% level	-2.935001	
	10% level	-2.605836	

*MacKinnon (1996) one-sided p-values.

Model 1: Descriptive Statistics

Descriptive Statistics

	Mean	Std. Deviation	N
UN1	.0338	.20195	42
INF	.2602	.71044	42
GDP	2.2143	4.14379	42
GFCF	6.0183	.39187	42
EX1	.0038	1.20824	42
DQ1	.2381	.43108	42
DQ2	.2619	.44500	42
DQ3	.2619	.44500	42
DCOVID	.1667	.37720	42

Model 1: The model summary with Durbin-Watson test result

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.769[a]	.592	.493	.14377	2.485

a. Predictors: (Constant), DCOVID, DQ3, INF, GFCF, DQ1, DQ2, GDP, EX1

b. Dependent Variable: UN1

Model 1: The analysis of variance of regression

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.990	8	.124	5.988	.000[b]
	Residual	.682	33	.021		
	Total	1.672	41			

a. Dependent Variable: UN1

b. Predictors: (Constant), DCOVID, DQ3, INF, GFCF, DQ1, DQ2, GDP, EX1

Model 1: The result of model 1 with VIF

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	.194	.406		.476	.637					
	INF	-.094	.041	-.329	-2.297	.028	-.470	-.371	-.255	.602	1.661
	GDP	-.003	.008	-.063	-.380	.706	-.434	-.066	-.042	.444	2.250
	GFCF	-.046	.068	-.088	-.667	.509	-.015	-.115	-.074	.704	1.420
	EX1	-.059	.029	-.353	-2.016	.052	-.496	-.331	-.224	.404	2.476
	DQ1	.238	.066	.507	3.607	.001	.348	.532	.401	.626	1.598
	DQ2	.145	.073	.320	2.000	.054	.127	.329	.222	.483	2.070
	DQ3	.131	.068	.289	1.918	.064	-.161	.317	.213	.544	1.839
	DCOVID	.102	.082	.190	1.237	.225	.331	.211	.138	.523	1.913

a. Dependent Variable: UN1

Model 1: The regression full model

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.769[a]	.592	.493	.14377	2.485

a. Predictors: (Constant), DCOVID, DQ3, INF, GFCF, DQ1, DQ2, GDP, EX1

b. Dependent Variable: UN1

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Model 1: The regression reduced model

Model Summary[b]

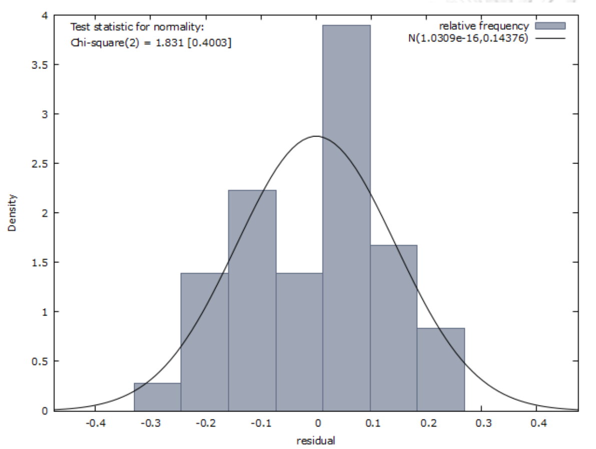
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.651[a]	.423	.343	.16365	2.490

a. Predictors: (Constant), DCOVID, EX1, INF, GFCF, GDP

b. Dependent Variable: UN1

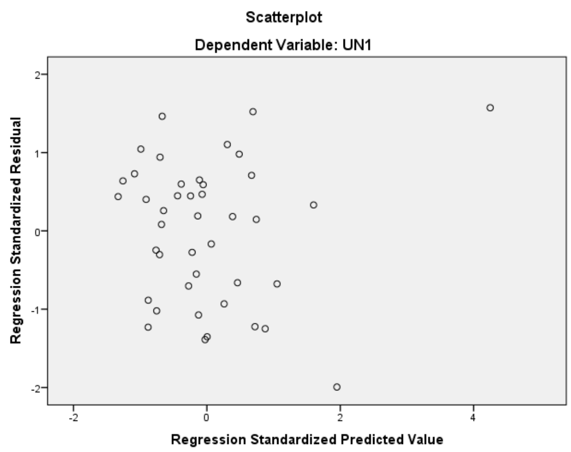
Model 1: Normality of residuals

```
Frequency distribution for residual, obs 1-42
number of bins = 7, mean = 1.03092e-016, sd = 0.143762

       interval          midpt   frequency    rel.     cum.

           < -0.24406   -0.28679       1      2.38%    2.38%
  -0.24406 - -0.15860   -0.20133       5     11.90%   14.29% ****
  -0.15860 - -0.073139  -0.11587       8     19.05%   33.33% ******
 -0.073139 -  0.012320  -0.030409      5     11.90%   45.24% ****
  0.012320 -  0.097779   0.055050     14     33.33%   78.57% ************
  0.097779 -  0.18324    0.14051       6     14.29%   92.86% *****
          >=  0.18324    0.22597       3      7.14%  100.00% **

Test for null hypothesis of normal distribution:
Chi-square(2) = 1.831 with p-value 0.40028
```



Model 1: Heteroskedasticity test

```
White's test for heteroskedasticity -
 Null hypothesis: heteroskedasticity not present
 Test statistic: LM = 37.7349
 with p-value = P(Chi-square(36) > 37.7349) = 0.38988
```



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Model 2: Descriptive Statistics

Descriptive Statistics

	Mean	Std. Deviation	N
UN1	.0338	.20195	42
INF	.2602	.71044	42
GDP	2.2143	4.14379	42
GFCF	6.0183	.39187	42
EX1	.0038	1.20824	42
DQ1	.2381	.43108	42
DQ2	.2619	.44500	42
DQ3	.2619	.44500	42
DCOVID	.1667	.37720	42
GDPGINF	1.3507	4.81896	42

Model 2: The model summary with Durbin-Watson test result

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
2	.801[a]	.642	.541	.13685	2.299

a. Predictors: (Constant), GDPGINF, GFCF, GDP, DQ1, DQ3, INF, DCOVID, DQ2, EX1

b. Dependent Variable: UN1

Model 2: The analysis of variance of regression

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
2	Regression	1.073	9	.119	6.366	.000[b]
	Residual	.599	32	.019		
	Total	1.672	41			

a. Dependent Variable: UN1

b. Predictors: (Constant), GDPGINF, GFCF, GDP, DQ1, DQ3, INF, DCOVID, DQ2, EX1

Model 2: The result of model 2 with VIF

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
2	(Constant)	-.006	.398		-.015	.988					
	INF	-.056	.043	-.197	-1.313	.198	-.470	-.226	-.139	.497	2.013
	GDP	-.009	.008	-.180	-1.072	.292	-.434	-.186	-.113	.396	2.527
	GFCF	-.011	.067	-.020	-.157	.876	-.015	-.028	-.017	.661	1.513
	EX1	-.037	.030	-.220	-1.233	.226	-.496	-.213	-.131	.353	2.833
	DQ1	.243	.063	.518	3.867	.001	.348	.564	.409	.625	1.600
	DQ2	.087	.074	.192	1.172	.250	.127	.203	.124	.417	2.400
	DQ3	.113	.066	.250	1.726	.094	-.161	.292	.183	.535	1.870
	DCOVID	.052	.082	.097	.634	.531	.331	.111	.067	.479	2.089
	GDPGINF	.014	.007	.328	2.103	.043	.503	.348	.223	.461	2.170

a. Dependent Variable: UN1

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