The Relationship of Vaccination with the Effectiveness of Covid-19 Control Policies in Indonesia

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Abstract:

This study aims to analyze the relationship between vaccination and the effectiveness of policies to overcome the Covid-19 pandemic in Indonesia. The quantitative analysis method with a dummy variable multiple regression approach was used to examine the vaccination times series data, cases, deaths and recoveries of Covid-19 patients for the period December 2020 – August 2021. The results show vaccination (especially dose 2) and the PPKM policy (Enforcement of Restrictions on Community Activities). have a significant impact on increasing cases, deaths and recoveries of Covid-19. Every 1,000 doses of vaccination has the potential to add 59 recovered patients, 46 new cases and 2 deaths. The impact on recovery is relatively higher than the impact on additional cases and deaths. A similar trend occurs when considering the impact of PPKM policies (micro, emergency and levels 1-4) on the increase in recovery, which is relatively higher than the similar impact on the rate of increase in cases and deaths. The impact on increasing cases and deaths can be said to be a risk that needs to be considered in future policy implementation.

Keywords: *Impact of Vaccination, Covid-19 Control Policies, PPKM*

Abstrak:

Penelitian ini bertujuan untuk menganalisis relasi vaksinasi dan efektivitas kebijakan penanggulangan pandemi Covid-19 di Indonesia. Metode analisis kuantitatif dengan pendekatan regresi ganda dummy variabel digunakan untuk menguji data times series vaksinasi, kasus, kematian dan kesembuhan pasien Covid-19 periode Desember 2020 – Agustus 2021. Hasilnya menunjukkan vaksinasi (terutama dosis 2) dan kebijakan PPKM (Pemberlakuan Pembatasan Kegiatan Masyarakat) berdampak signifikan terhadap peningkatan kasus, kematian dan kesembuhan Covid-19. Setiap 1.000 dosis vaksinasi berpotensi menambah 59 pasien sembuh, 46 kasus baru dan 2 kematian., Secara relatif dampak terhadap kesembuhan lebih tinggi disbanding dampak terhadap tambahan kasus dan kematian. Tren serupa terjadi ketika menimbang dampak kebijakan PPKM (mikro, darurat dan level 1-4) terhadap peningkatan kesembuhan relatif lebih tinggi dibanding dampak serupa terhadap tingkat peningkatan kasus dan kematian. Dampak terhadap

peningkatan kasus dan kematian dapat dikatakan sebagai risiko yang perlu dipertimbangkan dalam implementasi kebijakan di masa mendatang
Kata Kunci: Dampak Vaksinasi, Kenbijakan Penanggulangan Covid-19, PPKM

Introduction | المقدمة

Until mid-August 2021, the Covid-19 pandemic that has occurred since January 2020 still hit 221 countries from five continents. At least 208.65 million people have been confirmed positive for the coronavirus, with 4.383 million deaths. Every day there are about 520,000 new cases and 8000 new deaths.

The epicenter of the pandemic first occurred in Wuhan, China, then shifted to Europe and North America (mainly the US), then South America (Brazil), and Asia (India, Iran, Indonesia). China is now the only country that has been safe from the Covid pandemic, being in 107th position with a record of 94,430 cases and 4,636 deaths.

Globally, Indonesia is ranked 13th – after the US, India, Brazil, Russia, France, UK, Turkey, Argentina, Colombia, Spain, Iran and Italy – with 3,871,738 cases and 118,633 deaths. Every day during July-August an average of about 25,000 cases and 1,500 deaths occured. The peak of additional daily cases occurred on July 15, 2021 with 56,757 cases, while the peak of deaths occurred on July 27, 2021 with 2069.

Various policies and measures have been taken by many countries. Starting from the lockdown and regional quarantine policies, social distancing, working and studying from home, crowd restrictions, community activities restrictions, wearing masks, improving sanitation and disinfectants, tracking and taking action, to mass vaccination programs.

Indonesia has also made many prevention and control efforts, except for the national lockdown and regional quarantine. Indonesia initially appealed to the public to practice social distancing and Work from Home (WFH) and School From Home (SFH) or Distance Learning. After that, Indonesia established the Covid-19 Task Force, PSBB1, Transitional PSBB, New Normal, micro-scale PSBB, PPKM, PPKM Level 1-4, and finally mass vaccination.

Statistical data shows, when PPKM was implemented and mass vaccination was intensified, there was a spike in cases from thousands to tens of thousands, to 40-50 thousand for several weeks in July 2021, then began to decline to the level of 20-30 thousands in August 2021. Daily death rate also shot from hundreds to thousands, and had several times exceeded 2,000 deaths per day. In terms of additional daily cases, Indonesia was in the top five during July-August 2021. Meanwhile, in terms of additional daily deaths, Indonesia was in the top three, even being the highest for several weeks.

Entering the second week of August, there were interesting developments, along

with increasing the number of recipients of the first dose of vaccine and the second dose of vaccine, there was a trend of increasing cure rates. The daily case and daily death rates were still high, but the case and death rate growth was likely to slow down.

Is there a significant correlation between vaccination and the dynamics of the COVID-19 pandemic in Indonesia? Is vaccination effective in reducing the rate of cases and deaths from the pandemic, as well as increasing patient recovery rates? To answer this, the author proposes a study entitled: **The Relationship of Vaccination with the Effectiveness of Covid-19 Control Policies in Indonesia.**

Research Method | منهج البحث

This research uses quantitative analysis method with multiple regression dummy variable. The Covid-19 pandemic time series data used are official reports from the Covid-19 Task Force and Worldometer. Vaccine data is taken from the Vaccine Dashboard belonging to the Indonesian Ministry of Health (https://vacsin.kemkes.go.id/#/vaccines) and Statistics and Research. Coronavirus (COVID-19) Vaccinations Oxford University (https://ourworldindata.org/covid-vaccinations). There are four hypotheses proposed in this study, namely:

Hypothesis 1
H_{01} Vaccination has no effect on Covid-19 cases
H_{11} Vaccination affects Covid-19 cases

Hypothesis 2
H_{02} Vaccination has no effect on deaths from Covid-19
H_{12} Vaccination affects deaths from Covid-19

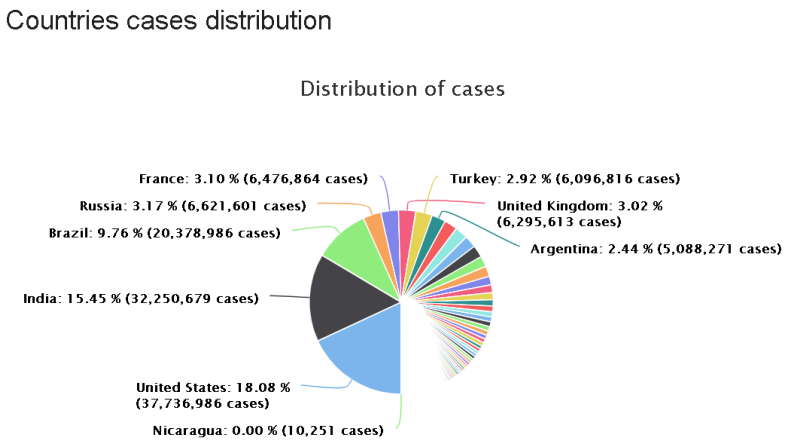
Hypothesis 3
H_{03} Vaccination has no effect on the recovery of Covid-19 patients
H_{13} Vaccination affects the recovery of Covid-19 patients

Hypothesis 4
H_{04} Differences in pandemic policies have no effect on overcoming Covid-19
H_{14} Differences in pandemic policies affect the handling of Covid-19

Discussion and Findings | مناقشة ونتائج البحث

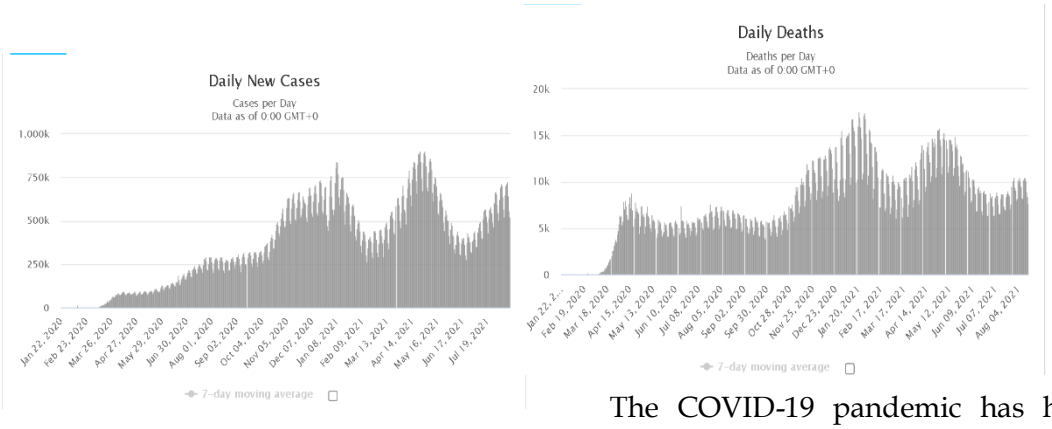
Coronavirus Disease 2019 (COVID-19) has become a pandemic, a global outbreak, spreading across continents. Entering mid-August 2021, the Coronavirus Disease 2019 (Covid-19) pandemic has touched more than 163.218 million cases and 3.384 million

deaths (Worldometer, 16/08/2021). They come from 220 countries on five continents. This outbreak has also worried more than 8.9 billion people in Asia, America, Europe, Australia, Africa and Antarctica. Some of them are forced to undergo a social distancing phase (maintain a safe distance, stay at home, work at home, even worship at home) for months. A condition that is quite dire in terms of the number and coverage of the outbreak area.



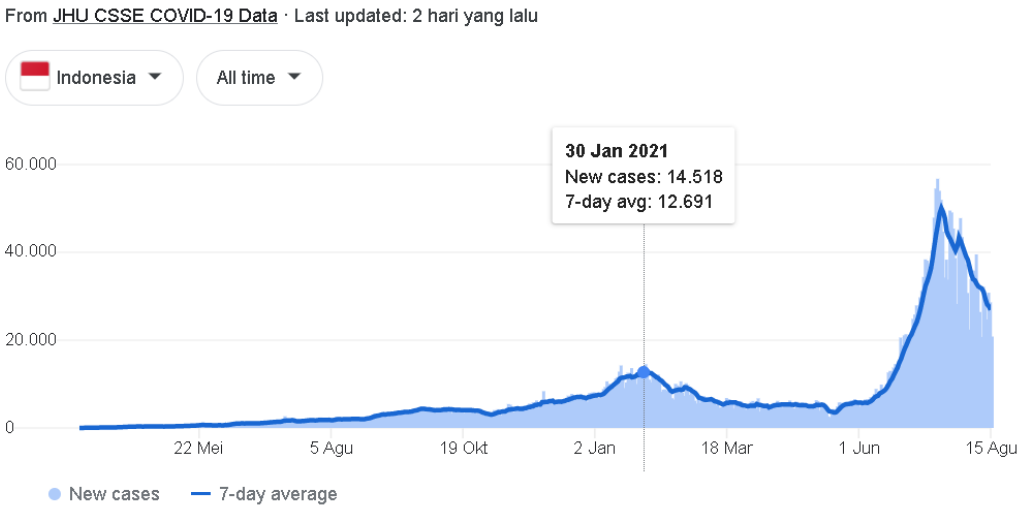
The pandemic has also had a tremendous impact on the world economy and the affected countries. The threat of recession and even depression is in sight. Even countries as strong as Singapore, South Korea, Japan, the United States, New Zealand, Britain, and France have experienced it. The impact is also experienced by Indonesia. In two consecutive quarters, national economic growth contracted to -5.32%. The IMF and the World Bank predict that the Covid-19 pandemic will trigger a global economic recession (Sri Mulyani, 2020).

Physically and psychologically, the Covid-19 pandemic has disturbed more than 8.9 billion people in Asia, America, Europe, Australia, Africa and Antarctica. Some of them are forced to undergo a social distancing phase (maintain a safe distance, stay at home, work at home, even worship at home) for months. A condition that is quite dire in terms of the number and coverage of the outbreak area.

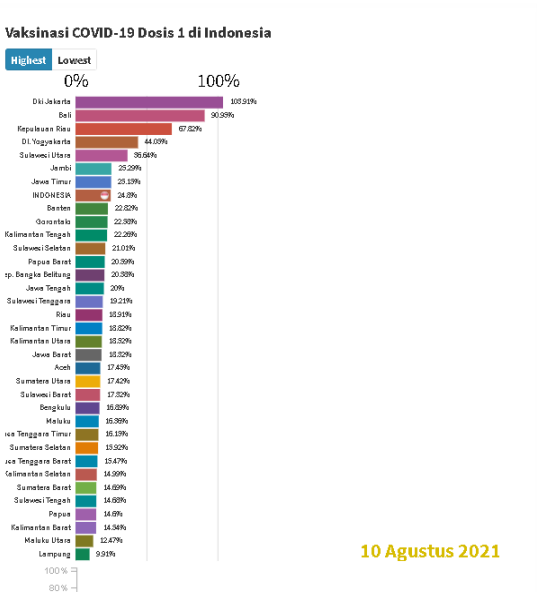


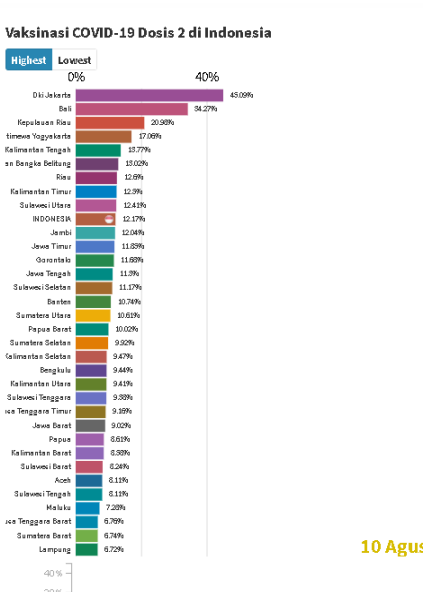
The COVID-19 pandemic has had a

multi-sectoral impact. For the economy, this pandemic has exacerbated the effects of economic contraction for countries in Asia, America, Africa, Europe and Australia/Oceania. Variables of pandemic cases, exposure time, population, regional differences and country status differences can explain the dynamics of the economic growth of the affected country by 63.73%, the remaining 26.27% is influenced by other variables not studied (Junaedi & Faisal, 2021).



To prevent, or at least suppress, the rate of transmission, a number of major affected countries have implemented lockdowns, regional quarantines, and large-scale social restrictions. (PSBB), travel restrictions, homecoming bans, Implementation of Community Activity Restrictions (PPKM), Micro PPKM, Emergency PPKM, as well as mass vaccinations and PPKM levels 1-4. A number of flights were suspended in many countries. Land and sea transportation is also restricted. A number of industries stopped production. Human movement is also prevented between countries, between provinces, between affected districts and cities. This condition makes economic activity also affected.

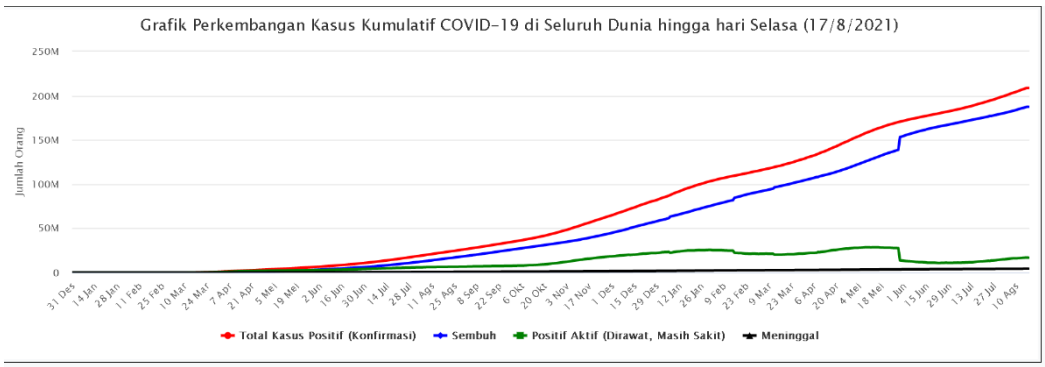


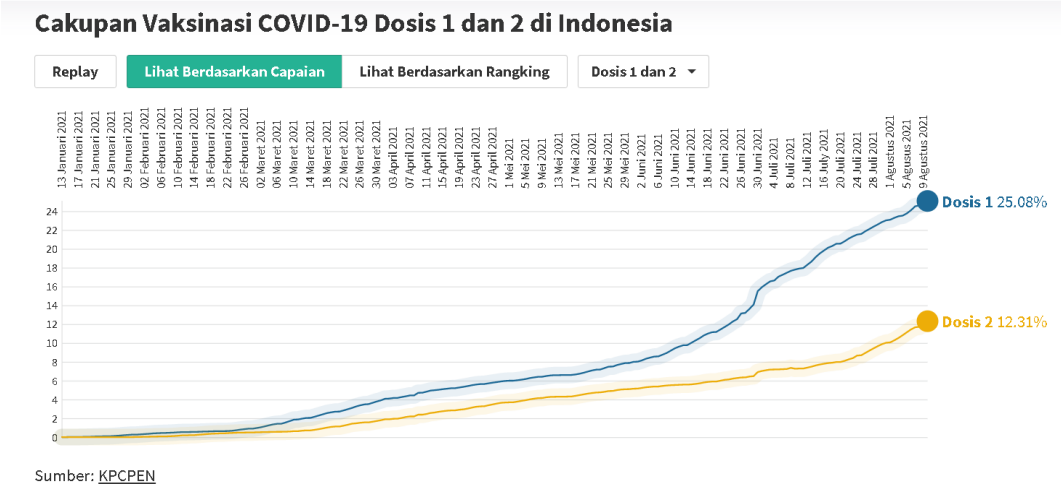


For more than six months in 2020, Bogor, Depok and Jakarta were among the red zone areas in Indonesia. Although the red zone area tends to decrease, the number of Covid-19 cases continues to increase from day to day throughout 2021. The growth graph is still increasing. There is no sign of a declining peak yet. To reduce the rate of transmission, distance learning for elementary – high school students or e-learning lectures for learning activities at the university level were carried out. The pandemic that was initially rife in Java-Bali has now spread to 34 provinces and 520 regencies/cities in Indonesia.

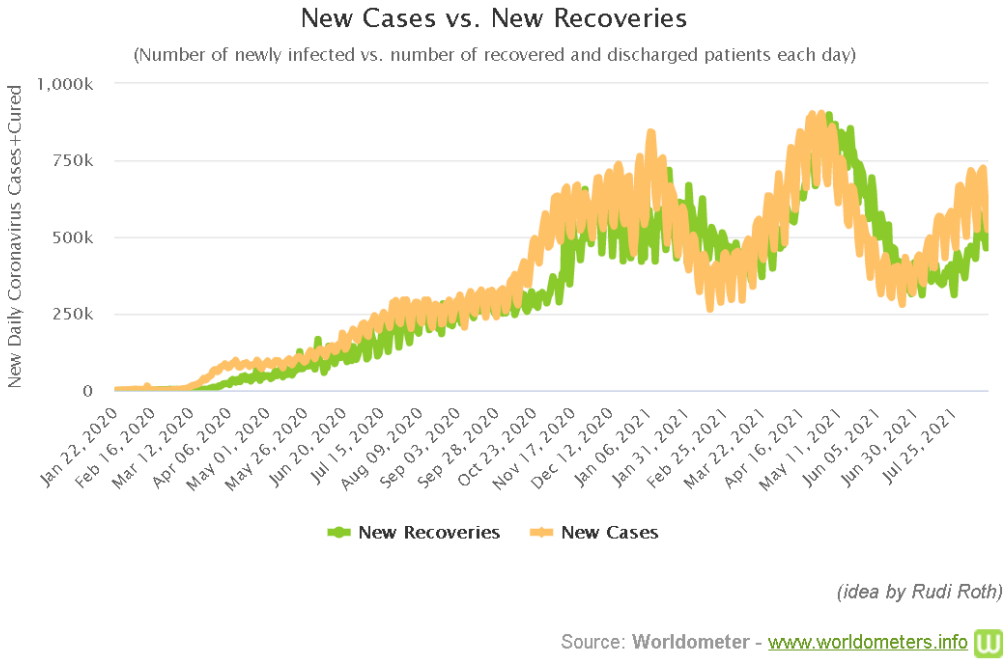
Vaccination has become an important part of dealing with the Covid-19 pandemic in Indonesia. As of August 16, according to the Indonesian Ministry of Health, Indonesia had only reached 40.5% of the target (208 million) or around 82.5 million people. When referring to the number of vaccine recipients, Indonesia is included in the list of 10 countries with the most Covid-19 vaccinations. First, China is the country that provides the highest vaccine dose to its citizens as many as 1.83 billion. India as of August 11 had delivered 523.67 million doses, followed by the United States at 353.86 million. Brazil 160.06 million doses, Japan 108.18 million doses, Germany 96.85 million doses, England as of 11 August 87.18 million doses, Indonesia 82.5 million doses, Turkey 81.44 million doses, and France as of 11 August 79.29 million doses.

Trends in the Covid-19 Pandemic and Vaccination in Indonesia



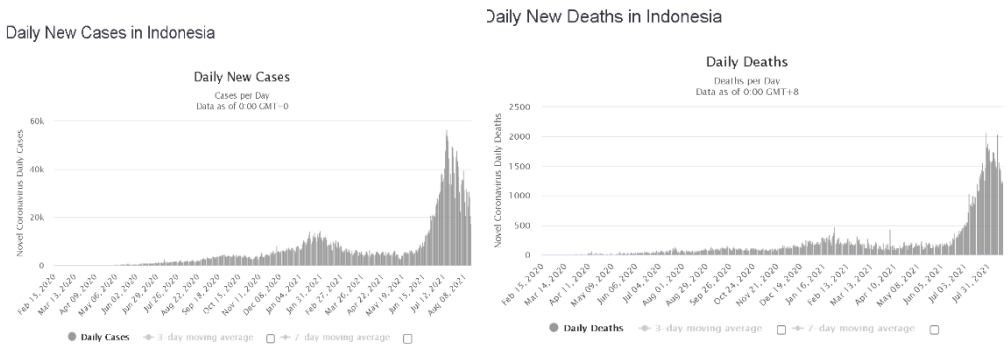


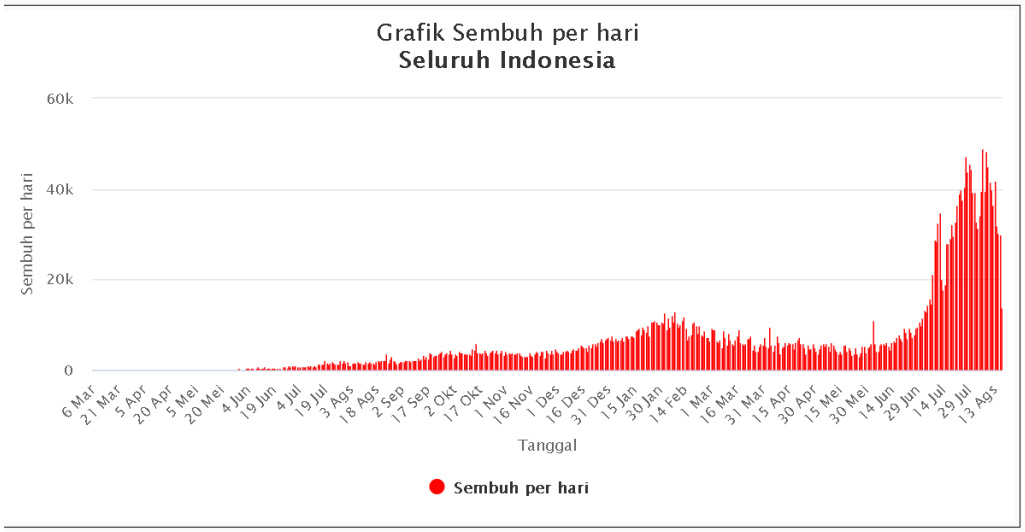
Sumber: KPCPEN



Statistical data shows that during the vaccination and PPKM period, there is a trend in the number of cases, deaths and recoveries from Covid-19 also increasing. From the figure, it can be seen that there is a trend intersection between the three parameters. There is a clear wedge between the addition of cases and the recovery rate. There were times when the trend of adding cases was higher than the trend of healing. There were also times when the trend of cures was higher or precedes the trend of additional cases.

The Effectiveness of Covid-19 Vaccination in Indonesia





The question arises whether there is a correlation between vaccination and the dynamics of cases, deaths, and recovery of Covid-19 in Indonesia. To answer this, a statistical analysis has been carried out using Eview 10 with time series data for the period December 2020 – August 15, 2021. The results are as follows:

Dependent Variable: KASUS_INA
Method: Least Squares
Date: 08/18/21 Time: 11:38
Sample (adjusted): 40 240
Included observations: 201 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
VAKSIN1	0.020673	0.002423	8.531412	0.0000
VAKSIN2	0.025750	0.004140	6.220493	0.0000
K2	138584.7	20750.92	6.678484	0.0000
K3	331405.8	41109.65	8.061508	0.0000
K4	827053.3	44854.05	18.43877	0.0000
C	1090769.	18633.75	58.53727	0.0000

R-squared	0.992321	Mean dependent var	1930989.
Adjusted R-squared	0.992125	S.D. dependent var	725868.6
S.E. of regression	64416.28	Akaike info criterion	25.01352
Sum squared resid	8.09E+11	Schwarz criterion	25.11212
Log likelihood	-2507.858	Hannan-Quinn criter.	25.05342
F-statistic	5040.076	Durbin-Watson stat	0.374246
Prob(F-statistic)	0.000000		

To ascertain whether these results can be used as the basis for further analysis, the classical assumption test was carried out. These include multicollinearity, autocorrelation, heteroscedality, linearity and normality. The test results show that the problems of heteroscedality, linearity, multicollinearity and normality can be overcome or pass the statistical test. Only autocorrelation did not pass the test. Therefore, four of the five classical assumption tests are met. So, the statistical model can be said to be valid to be used as the basis for decision-making analysis.

Summary of Classical Assumption Test Results

<table>
<tr><th>Classic assumption test</th><th>Test results</th><th>Explanation</th></tr>
<tr><td>Multicollinearity</td><td>
<table>
<tr><th>Variable</th><th>Coefficient Variance</th><th>Uncentered VIF</th><th>Centered VIF</th></tr>
<tr><td>DVAKSIN1</td><td>0.007683</td><td>2.828814</td><td>1.590798</td></tr>
<tr><td>DVAKSIN2</td><td>0.022896</td><td>2.835207</td><td>1.787512</td></tr>
<tr><td>K2</td><td>5.26E+09</td><td>1.207852</td><td>1.081028</td></tr>
<tr><td>K3</td><td>8.52E+09</td><td>1.116646</td><td>1.049647</td></tr>
<tr><td>K4</td><td>4.07E+09</td><td>2.002542</td><td>1.551970</td></tr>
<tr><td>C</td><td>1.07E+09</td><td>2.334932</td><td>NA</td></tr>
</table>
</td><td>Pass</td></tr>
<tr><td>Autocorrelation</td><td>Durbin-Watson stat 0,257169

Breusch-Godfrey Serial Correlation LM Test:
<table>
<tr><td>F-statistic</td><td>188.1835</td><td>Prob. F(2,193)</td><td>0.0000</td></tr>
<tr><td>Obs*R-squared</td><td>132.8664</td><td>Prob. Chi-Square(2)</td><td>0.0000</td></tr>
</table>
</td><td>Did not pass</td></tr>
<tr><td>Heteroscedality</td><td>Heteroskedasticity Test: ARCH
<table>
<tr><td>F-statistic</td><td>2.093129</td><td>Prob. F(1,197)</td><td>0.1496</td></tr>
<tr><td>Obs*R-squared</td><td>2.092150</td><td>Prob. Chi-Square(1)</td><td>0.1481</td></tr>
</table>
</td><td>Pass</td></tr>
<tr><td>Linearity</td><td>Ramsey RESET Test
Equation: UNTITLED
Specification: KASUS_INA DVAKSIN1 DVAKSIN2 K2 K3 K4 C
Omitted Variables: Squares of fitted values
<table>
<tr><th></th><th>Value</th><th>df</th><th>Probability</th></tr>
<tr><td>t-statistic</td><td>0.911334</td><td>193</td><td>0.3633</td></tr>
<tr><td>F-statistic</td><td>0.830530</td><td>(1, 193)</td><td>0.3633</td></tr>
<tr><td>Likelihood ratio</td><td>0.858807</td><td>1</td><td>0.3541</td></tr>
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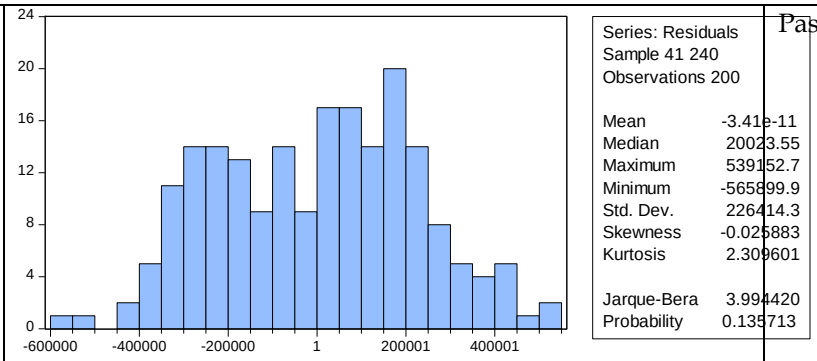
Normality		Pass

Impact of Vaccination on Covid-19 Cases

The results of statistical analysis show that the vaccination variable (dose 1 and dose 2) and the Covid-19 pandemic control policy (K2, K3, K4) simultaneously have a significant effect on the cumulative cases of Covid-19 in Indonesia with a coefficient of determination of 0.9923. This means that changes in vaccination and differences in policies to overcome the pandemic can explain the dynamics of the development of Covid-19 cases by 99.23%. Partially, vaccination dose 1 and dose 2 significantly affected the development of Covid-19 cases (standard error 5%, confidence level 95%). Likewise, the PPKM, Micro PPKM, Emergency PPKM and PPKM Level 1-4 policies are different from PSBB in terms of their impact on the development of Covid-19 cases in Indonesia. Relatively speaking, the impact of PPKM policies level 1-4, Emergency PPKM, Micro PPKM is higher than the impact of PSBB. While PPKM volume 1 and PPKM volume 2 are not significantly different from PSBB. The impact of PPKM levels 1-4 is higher than that of emergency PPKM. Likewise, emergency PPKM has more impact than micro PPKM.

The econometric model of the relation between vaccination and Covid-19 cases in Indonesia is as follows;

Covid-19 cases = 1090769 + 0,020673Vaksin1 + 0.025750Vaksin2 + 138584.7K2 + 331405.8K3 + 827053.3K4

Impact of Vaccination on Deaths Due to Covid-19

To test the effect of vaccination on the dynamics of death due to Covid-19, an analysis of the times series data for the period December 2020 – August 15 2021 has been carried out. The results are as follows:

Dependent Variable: MENINGGAL_INA
Method: Least Squares
Date: 08/18/21 Time: 11:40
Sample (adjusted): 40 240
Included observations: 201 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

VAKSIN1	-0.000106	0.000110	-0.960556	0.3380
VAKSIN2	0.002023	0.000188	10.73320	0.0000
K2	2294.968	944.7182	2.429262	0.0160
K3	9963.572	1871.581	5.323612	0.0000
K4	29137.88	2042.051	14.26893	0.0000
C	30509.07	848.3306	35.96366	0.0000

R-squared	0.981028	Mean dependent var	52975.75
Adjusted R-squared	0.980541	S.D. dependent var	21023.47
S.E. of regression	2932.652	Akaike info criterion	18.83460
Sum squared resid	1.68E+09	Schwarz criterion	18.93320
Log likelihood	-1886.877	Hannan-Quinn criter.	18.87450
F-statistic	2016.643	Durbin-Watson stat	0.253833
Prob(F-statistic)	0.000000		

The results of statistical analysis show that simultaneously the vaccination variable and differences in pandemic policies have a significant impact on the death rate due to Covid-19 in Indonesia with a coefficient of determination of 0.9810. This means that the independent variable used can explain the dynamics of the mortality rate of 98.1%. The rest is explained by other variables that are not examined.

Partially, dose 2 vaccination, micro PPKM policies, emergency PPKM and PPKM levels 1-4 have a significant effect on the dynamics of the death rate due to Covid-19 in Indonesia at the 95% confidence level (standard error 5%). These four independent variables are positively correlated with mortality. Meanwhile, dose 1 vaccination tends to be negatively correlated with mortality, but the impact or correlation is not significant.

The econometric model of the relation between vaccination and death from Covid-19 is as follows:

$$\text{Covid-19 deaths} = 30509.07 + 0.002023\text{VAKSIN2} + 2294.968\text{K2} + 9963.572\text{K3} + 29137.88\text{K4}$$

Impact of Vaccination on Healing of Covid-19 Patients

To test the impact of vaccination and Covid-19 control policies on the recovery rate of Covid-19 patients, a statistical analysis has been carried out. The results are as follows:

Dependent Variable: SEMBUH_INA
Method: Least Squares

Date: 08/18/21 Time: 11:41
Sample (adjusted): 40 240
Included observations: 201 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
VAKSIN1	0.000867	0.002311	0.375121	0.7080
VAKSIN2	0.058919	0.003949	14.92102	0.0000
K2	175990.7	19794.26	8.890993	0.0000
K3	276705.2	39214.41	7.056211	0.0000
K4	655096.7	42786.19	15.31094	0.0000
C	896167.5	17774.70	50.41816	0.0000

R-squared	0.989183	Mean dependent var	1672688.
Adjusted R-squared	0.988905	S.D. dependent var	583361.3
S.E. of regression	61446.56	Akaike info criterion	24.91912
Sum squared resid	7.36E+11	Schwarz criterion	25.01773
Log likelihood	-2498.372	Hannan-Quinn criter.	24.95902
F-statistic	3566.289	Durbin-Watson stat	0.257169
Prob(F-statistic)	0.000000		

Simultaneously, vaccination variables (dose 1 and dose 2) and differences in policies (micro PPKM, emergency PPKM and PPKM levels 1-4) significantly affected the recovery rate of Covid-19 patients with a coefficient of determination of 0.989183. This means that all the independent variables in this study can explain the change in the recovery rate of Covid-19 patients by 98.92%. The rest, 1.08% is explained by other variables that are not used in this study.

Partially, the dose 2 vaccine variable and the micro PPKM, emergency PPKM and PPKM levels 1-4 have a significant effect on the dynamics of healing Covid-19 patients with a 95% confidence level (standard error 5%). The econometric model of the relation between vaccination and the recovery of Covid-19 patients is as follows:

Patient Recover = 896167.5 + 0.058919VAKSIN2 + 175990.7K2 + 276705.2K3 +

655096.7K4

The results of statistical analysis show that vaccination (especially dose 2) has a significant impact on increasing cases, deaths and recovering Covid-19. The relative impact on recovery is higher than the impact on additional cases and deaths. On the other hand, the impact of vaccination on deaths from Covid-19 is lower than the impact on increasing cases and increasing patient recovery rate.

From the results of statistical analysis of the data as of September 15, 2021, three

econometric models were obtained as follows:

Covid-19 Case = 1090769 + 0,020673Vaksin1 + 0.025750Vaksin2 + 138584.7K2 +
331405.8K3 + 827053.3K4 (1)

Covid-19 Death = 30509.07 + 0.002023VAKSIN2 + 2294.968K2 +
9963.572K3 + 29137.88K4 (2)

Patient Recovery = 896167.5 + 0.058919VAKSIN2 + 175990.7K2 + 276705.2K3 +
655096.7K4 (3)

From the econometric model (3) it can be interpreted that every 1000 vaccinations has the potential to increase the recovery of around 59 Covid-19 patients. At the same time, based on the econometric model (1), there were an additional 46 new cases of Covid-19, which came from vaccination dose 1 (21) and vaccination dose 2 (25). Meanwhile, from the econometric model (2), there is a potential for additional 2 (two) deaths due to Covid-19.

A similar trend occurs when considering the impact of the Covid-19 response policy on increasing recovery, which is relatively higher compared to the similar impact on the increase in cases and deaths. The impact on mortality is relatively smaller compared to the impact on the number of cases and recoveries.

Thus, if the target of vaccination and policy is to increase recovery rate, this goal has been met. However, data shows that the implementation of vaccination and PPKM policies carries a risk of an increase in cases and deaths. To reduce the risk of secondary impacts, more scrupulous and careful steps are needed in the implementation of the vaccination program and PPKM policies in the field. The presence of a number of cases in the field indicates the need for more precise and careful screening in determining vaccination targets.

Conclussion | خاتمة

From the results of statistical analysis of time series data in the period December 2020 – August 2021, it shows that vaccination (especially dose 2) has a significant impact on increasing cases, deaths and recoveries of Covid-19 patients. Relatively the impact on patient recovery is higher than the impact on additional cases and deaths. In contrast, the impact of vaccination on deaths from Covid-19 is lower than the impact on increasing cases and recovery rates.

A similar trend occurs when considering the impact of the Covid-19 response policy on increasing recovery, which is relatively higher compared to the similar impact on the increase in cases and deaths. The impact on mortality is relatively smaller compared to the impact on the number of cases and recoveries.

Thus, if the target of vaccination and policy is to increase recovery rate, this goal has been met. However, data shows that the implementation of vaccination and PPKM policies carries a risk of an increase in cases and deaths. To reduce the risk of secondary impacts, more scrupulous and careful steps are needed in the implementation of the vaccination program and PPKM policies in the field. The presence of a number of cases in the field indicates the need for more precise and careful screening in determining vaccination targets.

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