The effect of Covid-19 and population mobility on the underemployment rate in Indonesia

Pengaruh COVID-19 dan Mobilitas Penduduk terhadap Tingkat Setengah Pengangguran di Indonesia

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ABSTRACT

Indonesia's underemployment rate experienced a marked increase in 2020 by 3.77% from the previous year. The increase is twice the unemployment rate. The number of people aged 15 years or older who experienced reduced working hours due to COVID-19 was nine times higher than those who became unemployed. This research aimed to analyse the effect of COVID-19 cases and population mobility on the underemployment rate in Indonesia. The method used in this research is panel data regression with the Feasible Generalised Least Square-Seemingly Unrelated Regression (FGLS-SUR). More research is still needed on the underemployment rate, especially studies that empirically investigate why the underemployment rate increased so much during the COVID-19 pandemic. This study uses panel data at the provincial level with a fixed effect model that allows us to analyse the individual effects of each province. Individual effects will enable us to analyse how the underemployment rate changes when the variable under study is constant. The study results show that population mobility, economic growth, minimum wage, education, and population have a significant negative effect on the underemployment rate. In contrast, Covid-19 cases have a positive but insignificant effect on the underemployment rate.

Keywords: Covid-19, population mobility, underemployment rate

ABSTRAK

Tingkat setengah pengangguran di Indonesia mengalami peningkatan pesat pada tahun 2020 sebesar sebanyak 3,77% dari tahun sebelumnya. Kenaikan ini dua kali lipat lebih besar dibanding tingkat pengangguran terbuka. Selanjutnya, jumlah penduduk berumur 15 tahun ke atas yang mengalami pengurangan jam kerja akibat COVID-19 sembilan kali lebih besar dibandingkan dengan mereka yang menganggur karena kondisi ini. Penelitian ini bertujuan untuk menganalisis pengaruh kasus COVID-19 dan mobilitas penduduk terhadap tingkat setengah pengangguran di Indonesia. Metode yang digunakan dalam kajian ini adalah regresi data panel dengan metode estimasi Feasible Generalized Least Square-Seemingly Unrelated. Kajian terkait tingkat setengah pengangguran masih sangat dibutuhkan, terutama yang memberikan penjelasan empiris mengapa tingkat setengah pengangguran meningkat pesat selama pandemi COVID-19. Kajian ini menggunakan data panel pada tingkat provinsi dengan menggunakan model fixed effect yang memungkinkan analisis pengaruh individu di tiap provinsi. Pengamatan terhadap pengaruh individu dapat menjelaskan bagaimana perubahan tingkat setengah pengangguran ketika variabel yang dikaji bersifat konstan. Hasil dari kajian ini menunjukkan bahwa mobilitas penduduk, pertumbuhan ekonomi, upah minimum, pendidikan, dan jumlah penduduk memiliki pengaruh negative yang signifikan terhadap tingkat setengah pengangguran, sedangkan kasus COVID-19 memiliki pengaruhi positif yang tidak signifikan terhadap tingkat setengah pengangguran.

Kata kunci: COVID-19, mobilitas penduduk, tingkat setengah pengangguran

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INTRODUCTION

Covid-19 is an infectious disease caused by *Severe Acute Respiratory Syndrome Coronavirus 2* (SARS-CoV-2). The Covid-19 case was detected in Wuhan, China, in December 2019. This virus spread quickly to various countries. Therefore, on January 30, 2020, WHO declared a public health emergency and categorized Covid-19 as a pandemic on March 11, 2020 (WHO, 2020a, 2020b). As of December 31, 2022, the WHO noted that there were more than 730 million cases of Covid-19 with the number of deaths exceeding 6.6 million cases. Of those who have symptoms of Covid-19, approximately 15% are seriously ill and require oxygen, while an additional 5% are critical and need intensive care (WHO, 2021). Research has shown that the average rate of spread of Covid-19 tends to be higher than that of other viruses such as SARS, MERS, Ebola, and various strains of influenza, including the 1918 (H1N1), 1957 (H2N2), 1968 (H3N2), and 2009 (H1N1) pandemics (Petersen *et al*., 2020; Pitlik, 2020). This fact then raises concerns about the adequacy of the capacity of health facilities if Covid-19 spreads out of control.

Covid-19 spreads through close contact with an infected person. Mobility restrictions, often called "lockdowns" can slow the transmission of Covid-19 by limiting human-to-human contact (WHO, 2020). Studies (Alfano & Ercolano, 2020) have shown that the lockdown was effective in reducing the number of new cases of Covid-19 in the countries that implemented it. However, mobility restrictions have an impact on many sectors of life, including the economic sector (Correia *et al*., 2020; Crossley *et al*., 2021; Guo *et al*., 2021; Haldar & Sethi, 2022; Kong & Prinz, 2020; Onyeaka *et al*., 2021; Su *et al*., 2022). The labor market is one part of the economic sector that has been affected by the Covid-19 pandemic (Almeida & Santos, 2020; Li *et al*., 2023; Parker & Hutti, 2022; Paterson-Young, 2021; Webb *et al*., 2020; Zhang, 2022).

According to ILO (2021), the Covid-19 pandemic had a significant impact on the labor market. Global unemployment increased by 33 million people between 2019 and 2020. This increase was higher than during the economic crises between 2008 and 2009, which saw an increase of 22 million people. Additionally, the Covid-19 pandemic is expected to reduce total working hours by 8.8 percent, which is equivalent to the working hours of 255 million full-time workers for a year. This situation contrasts with the conditions during the global economic crisis in 2008 and 2009, where the total hours worked experienced an increase of 0.2 percent (ILO, 2021).

In Indonesia, the Covid-19 case was detected for the first time on March 2, 2020. The rate of Covid-19 cases in Indonesia continues to increase, so on March 31, 2020, the Indonesian government implemented Large-Scale Social Restrictions or *Pembatasan Sosial Berskala Besar* (PSBB) as stipulated in Government Regulation or *Peraturan Pemerintah* (PP) Number 1 of 2020 regarding Large-Scale Social Restrictions in the Context of Accelerating Handling of Covid-19. The implementation of the PSBB was then followed by an increase in unemployment and underemployment in Indonesia.

Figure 1 shows that both the unemployment rate and the underemployment rate experienced a sharp increase in 2020. The underemployment rate in Indonesia increased by twice the amount of the unemployment rate. The unemployment rate rose from 5.23 percent to 7.07 percent, an increase of 1.84 percent; while the underemployment rate increased from 6.42 percent to 10.19 percent, representing a rise of 3.77 percent. The distribution of underemployment rate, which varies considerably between provinces can be seen in Figure 2.

Figure 1. Indonesia's underemployment rate and unemployment rate, 2015–2022

Figure 2 shows the province with the highest underemployment rate in 2020 is Nusa Tenggara Barat at 16.83 percent, and the province with the lowest underemployment rate is Riau Islands by 5.75 percent. The range between the highest and the lowest provincial underemployment rates in Indonesia is 11 percent, indicating significant variations. An increase in the underemployment rate, greater than the unemployment rate, can occur due to a reduction in working hours to less than 35 hours a week. Badan Pusat Statistik (2021) stated that the average annual working hours of residents aged 15 years and over working in Indonesia have decreased due to the Covid-19 pandemic, from 2,133.88 hours in 2019 to 1,977.00 hours in 2020. When a worker experiences a decrease in working hours to less than 35 hours a week, then they will be categorized as underemployed.

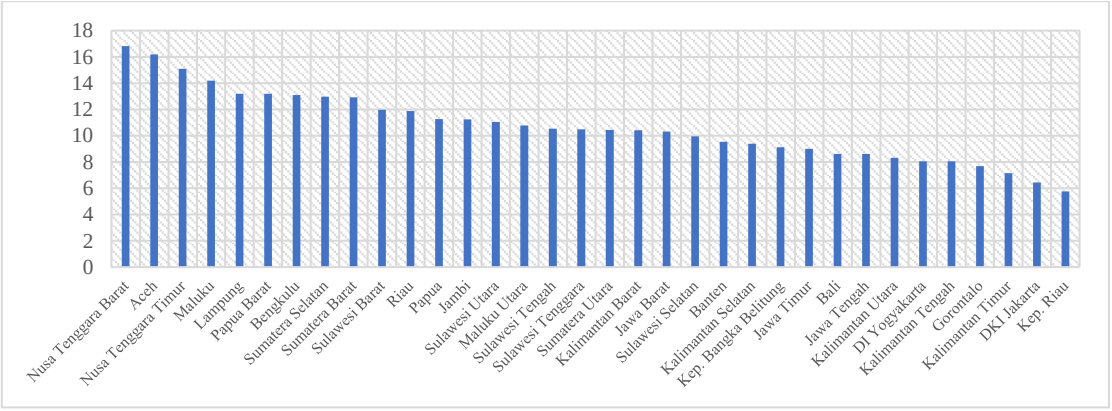


Figure 2. The provincial underemployment rate in Indonesia, 2020

The reduction in working hours can be caused by several factors, including Covid-19 cases and population mobility (Ang & Dong, 2022; Béland *et al*., 2020; Munawar *et al*., 2021). According to data on Badan Pusat Statistik (2020), which is the Indonesian Central Statistics Strategy, companies tend to maintain their workforce and avoid termination of employment. However, due to the heavy impact of the pandemic on company activities, reducing working hours has become a relatively common measure. Around 33 percent of companies reduced their employees' working hours in July 2020, and 22.2 percent in October 2020, (Badan Pusat Statistik, 2020a, 2020b). In addition, there were 24.03 million people of working age who experienced reduced working hours due to Covid-19 in 2020, while 2.56 million people were unemployed (Badan Pusat Statistik, 2020c). The effects of Covid-19, as highlighted by Tusianti & Awwaliyah (2021) include fear of infection, regulations limiting mobility, and self-quarantine among the working-age population.

Reducing working hours is related to reducing income and purchasing power, which can lead to increased poverty (Badan Pusat Statistik, 2021d; Crossley *et al*., 2021; Su *et al*., 2022). Badan Pusat Statistik (2021a) noted that 36.49 percent of workers experienced a decrease in wages during the Implementation of restrictions on community activities. Additionally, the average monthly wage/net salary for workers/employees

decreased to IDR 2,760,000.00 compared to August 2019 (Badan Pusat Statistik, 2020d). As an effort to eradicate poverty and achieve sustainable development, the ILO through the Decent Work Agenda, advocating that everyone should have the opportunity to secure a job that guarantees their livelihood. Decent working hours (no less and no more) are one indicator of decent work. Insufficient working hours indicate that workers' abilities are not being optimally utilized, resulting in suboptimal income, especially if they are paid based on the length of their work (Badan Pusat Statistik, 2021d). The underemployment rate is a measure that indicates the number of workers with fewer working hours, thus a high underemployment rate suggests a significant portion of workers still lack decent jobs (Badan Pusat Statistik, 2021d).

Not much research has been conducted on the underemployment rate. Previous studies tended to analyze the demographic characteristics of underemployment using logistic regression. Research by Kinanti (2015) and Pratomo (2015) shows that gender, age, and education significantly influence the probability of a person becoming underemployed. Despite the limited research on the underemployment rate, studies investigating the effect of the Covid-19 cases and population mobility on the underemployment rate are rare or never been done, despite the significant impact of the Covid-19 pandemic on reducing working hours. Most previous studies focused on how the Covid-19 cases and population mobility affected unemployment. Previous studies have demonstrated a negative relationship between population mobility and unemployment (Haldar & Sethi, 2022; Marcén & Morales, 2021; Ngo *et al.*, 2022). There are two perspectives explaining the relationship between the increase in Covid-19 cases and unemployment: an increase in Covid-19 cases can either increase unemployment (Aum *et al*., 2020; Beland *et al*., 2020; Chen *et al*., 2020; Sjoquist & Wheeler, 2021; Su *et al*., 2022) or reduce unemployment (Green & Loualiche, 2021; Jackson *et al*., 2021; Ngo *et al*., 2022).

This research makes several contributions compared to previous studies. First, it focuses on the underemployment rate. Despite the significant the significant impact of the covid-19 pandemic on employment, there remains a paucity of research on the underemployment rate, particularly studies that empirically investigate the reasons behind the substantial increase observed at the onset of the pandemic in 2020. Secondly, building upon the insights of Sjoquist & Wheeler (2021), who emphasized that the effects of Covid-19 and various policies are contingent upon the size of a region's economy, this study utilizes provincial-level panel data and employs a fixed effect model. This approach enables us to analyze the individual effects of each province. By considering individual effects, we can discern how the underemployment rate changes when the variable under study remains constant.

Based on the background described, this research was conducted with the following aim (1) to provide an overview of the underemployment rate, Covid-19 cases, population mobility, and other socio-economic variables; and (2) to analyze the influence of the Covid-19 case, population mobility, and other socio-economic variables on the underemployment rate in Indonesia from 2020 to 2022. Our results can serve as valuable learning material for policymakers in planning for future lockdowns during times of disaster, pandemics, or social distancing upheaval. Conducting analysis at the provincial level is essential for fully understanding and effectively managing the impact of the pandemic. Moreover, given the uncertainty surrounding future pandemics, it is crucial to be prepared for potential future crisis.

By analyzing data from 34 provinces in Indonesia over the period of 2020–2022, this study revealed that an increase in population mobility was associated with a significant reduction in the underemployment rate. Conversely, an increase in Covid-19 cases was found to potentially increase the underemployment rate, although the effect was not statistically significant. Furthermore, the study found that mobility restriction regulations can significantly increase underemployment, while an increase in Covid-19 cases insignificantly contributed to underemployment. This discrepancy may be attributed to various policies that allow workers

to maintain their working hours even if they are infected with Covid-19 or are afraid of being infected with Covid-19. The research results also indicate that an increase in the minimum wage, economic growth, education, and population can lead to a decrease in the underemployment rate. This trend is attributed to economic growth generating more job opportunities, an expanding working-age population and higher education levels enabling increased working hours through new online job opportunities, and an increase in the minimum wage incentivizing individuals to work longer hours, thereby reducing underemployment.

Covid-19 cases, population mobility, and underemployment rate

Underemployment reflects the underutilization of the productive capacity of persons in employment (ILO, n.d.). It encompasses several types, including time-related underemployment, skill-related underemployment, and income-related underemployment. The 16th International Conference of Labour Statistics (ICLS) recommendations concerning the measurement of underemployment primarily focus on time-related underemployment (Hussmanns, n.d.). Time-related underemployment refers to workers whose working hours are significantly lower than the standard or normal working hours. According to the definition provided by Badan Pusat Statistik (2021d), underemployment occurs when workers' working hours fall below the threshold of normal working hours, typically less than 35 hours per week, and they are still actively seeking or available for additional work. The underemployment rate is calculated by the following formula:

$$UR(\%) = \frac{the\ number\ of\ underemployed}{working\ population\ 15\ years\ and\ over} \times 100\% \quad (1)$$

Covid-19 affects the labor market through several intermediaries, including direct exposure to Covid-19 and restrictions on mobility (Eichenbaum *et al*., 2020; ILO, 2021). The prevalence of Covid-19 can reduce the labor supply due to illness and the need for infected individuals to quarantine (Beland *et al*., 2020; ILO, 2021). Research supports the notion of a positive relationship between Covid-19 and unemployment (Aum *et al*., 2020; Beland *et al*., 2020; Chen et al., 2020; Katris, 2021; Sjoquist & Wheeler, 2021; Su *et al*., 2022). Therefore, it is hypothesized that Covid-19 has a positive effect on the underemployment rate.

Another intermediary for Covid-19 in the labor market is population mobility. During the Covid-19 pandemic, population mobility was limited by the mobility policies implemented by the government. Mobility restriction policies can reduce labor demand (ILO, 2021). The impact of the mobility restriction policy on the workforce can be through limiting company operations or closing several non-essential companies (Beland *et al*., 2020; ILO, 2021; Kong & Prinz, 2020). Restrictions on the company's operations force the company to reduce its output; the reduction in output then has an impact on reducing the demand for labor (ILO, 2021). On the other hand, when population mobility is limited, people's consumption decreases (Baker et al., 2020; ILO, 2021; Kong & Prinz, 2020). Reducing public consumption will reduce aggregate demand so that it can reduce output companies and lead to a decrease in the demand for labor (Haldar & Sethi, 2022; ILO, 2021; Marcén & Morales, 2021; Ngo et al., 2022). Therefore, it is hypothesized that mobility has a negative effect on unemployment.

The economic growth, education, and underemployment rate

Okun's law explains the relationship between unemployment and economic growth (Mankiw, 2022). Gross Domestic Product (GDP) data is used to measure economic growth, which measures the total income in a country's economy (Mankiw, 2022). BPS defines GDP as the total added value generated by all business units in a particular country or as the total value of final goods and services produced by all economic units. GDP is an indicator at the national level, while at the regional level, GRDP is used (Badan Pusat Statistik, 2023). According to Okun's law, a one percent increase in unemployment is associated with an increase in GDP growth of about 2 percent (Mankiw, 2022). Therefore, it is

hypothesized that economic growth has a negative effect on unemployment.

Borjas (2013) mentions that education is negatively related to unemployment. Education is closely related to human capital. Mankiw (2022) mentions that human capital is the knowledge and skills workers acquire through education. Mean Years Schooling (MYS) describes the stock of human capital owned by a region (Badan Pusat Statistik, 2021b). Badan Pusat Statistik (2021b) defines MYS as the number of years lived by residents aged 25 years and over in formal education. Previous studies have stated that low-skilled workers tend to be more affected by Covid-19 by becoming unemployed or experiencing reduced working hours (Su *et al*., 2022). Therefore, it is hypothesized that education has a negative effect on unemployment.

One of the goals of work is to earn income. Increasing the minimum wage can increase the supply of labor (Borjas, 2013). Mankiw (2022) states that the minimum wage has the greatest impact on youth unemployment, empirically showing that an increase in the minimum wage of 10 percent can reduce youth unemployment by 1-3 percent. Therefore, it is hypothesized that wages have a negative effect on unemployment. In the economy at large, the supply of labor depends on the choices made by everyone in the population (Asri et al., 2023; Borjas, 2013; Kartiasih et al., 2023; 2023a). Therefore, population is one of the important factors affecting unemployment. Research shows that population has a positive effect on unemployment (Maijama'a *et al*., 2019; Sibagariang *et al*., 2023; Siddiqa, 2021; Widiyasari *et al*., 2023). Therefore, it is hypothesized that the population by proxy of the number of people of working age has a positive effect on unemployment.

METHODS

This research utilizes panel data from 34 provinces spanning the years from 2020 to 2022. The data employed are secondary data and elaboratedly described in detail in Table 1.

Table 1. Data description

Variable	Definition	Data source
Dependent Variable		
Underemployment rate	Underemployment rate in percent	BPS - Statistics Indonesia (Sakernas March)
Independent Variable		
Covid-19	Average daily Covid-19 cases over the year	Google Open Data
Mobility	Average daily *Google Mobility Index*[1] for the categories retail and recreation, groceries and pharmacies, transit stations, and workplaces for a year in percent.	Google Open Data
Economic growth	GRDP growth rate in percent	BPS - Statistics Indonesia
Wage	Provincial minimum wage per month in rupiah	BPS - Statistics Indonesia and Ministry of Manpower
Education	Mean Years Schooling in years	BPS - Statistics Indonesia (Susenas August)
Population	Total population of working age (15 years and over) in million people	BPS - Statistics Indonesia (Sakernas March)

[1] *Google Mobility Index* shows the number of visits (or time spent) for each place category compared to the *baseline* (median value from January 3 to February 6, 2020) or it can be called before the Covid-19 pandemic period.

This study employes descriptive analysis and inference. Descriptive analysis involves the use of graphs and thematic maps that present an overview of various factors such as underemployment rate, Covid-19 cases, population mobility, economic growth, minimum wages, education, and the population in 2020-2022. The inferential analysis, on the other hand, utilizes panel data regression to examine the influence of independent variable on the

dependent variable. The model specifications used in this research are depicted in equation (2):

$$UR_{it} = \beta_0 + \beta_1 Covid_{it} + \beta_2 Mobility_{it} + \beta_3 EcoGrowth_{it} + \beta_4 Education_{it} + \beta_5 \text{Wage}_{it} + \beta_6 Pop_{it} + u_{it} \quad (2)$$

In Equation (2), i shows a unit cross section (province) while t it shows time series (year). β_0 shows intercept. β_k shows the *k*-th independent variable regression coefficient. UR_{it} shows the underemployment rate of the *i*-th province in the *t*-year. $Covid_{it}$ shows the *i*-th province's daily Covid-19 cases in year *t*. $Mobility_{it}$ shows the mobility of the population of the *i*-th province in the *t*-th year. $EcoGrowth_{it}$ shows the economic growth of the *i*-th province in the *t*-year. $Education_{it}$ shows the education of the *i*-th province in the *t*-year. Wage_{it} shows the growth of the minimum wage for the *i*-th province in the *t*-th year in natural logarithm form. Pop_{it} shows the population of the *i*-th province in the *t*-th year. u_{it} is the error component for the *i*-th province in the *t*-th year which is the sum of (μ_{it} unobservable individual effects) and (v_{it} other error components).

RESULT AND DISCUSSION

The provincial underemployment rate in Indonesia has shown a tendency to decrease during the 2020–2022 period. An overview of the underemployment rate for 34 provinces in Indonesia during this period is presented in Figure 4. This Figure indicates that the decline in the underemployment rate in 2022 is expected to be greater than the decrease observed in 2021. Nusa Tenggara Barat has the highest average underemployment rate, while DKI Jakarta has the lowest. Notably, DKI Jakarta Province also experienced the highest decrease in the underemployment rate in 2022, amounting to 4.05 percent. However, it is interesting to note that the underemployment rate in Sulawesi Barat sharply increased in 2022, unlike other provinces which experienced a decline.

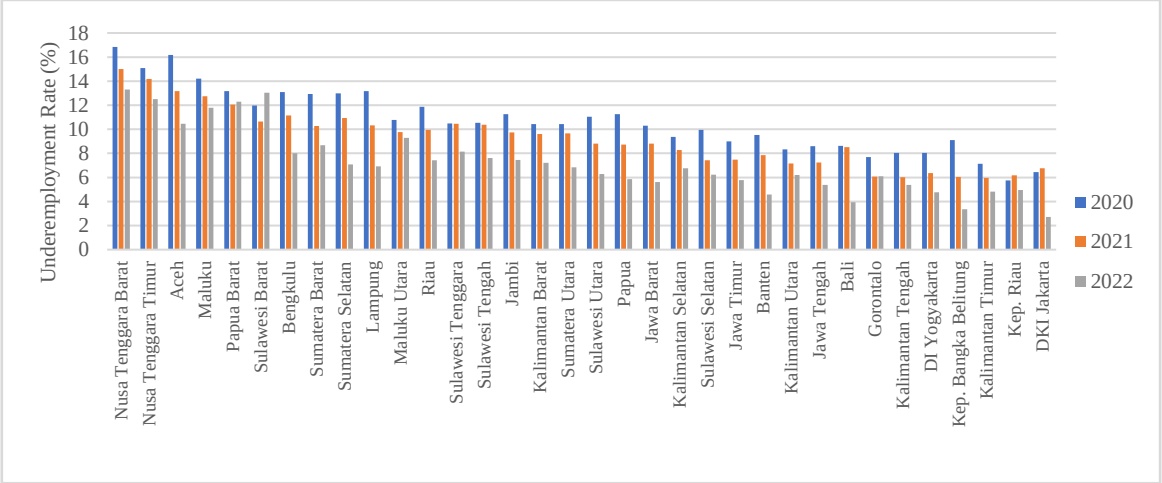
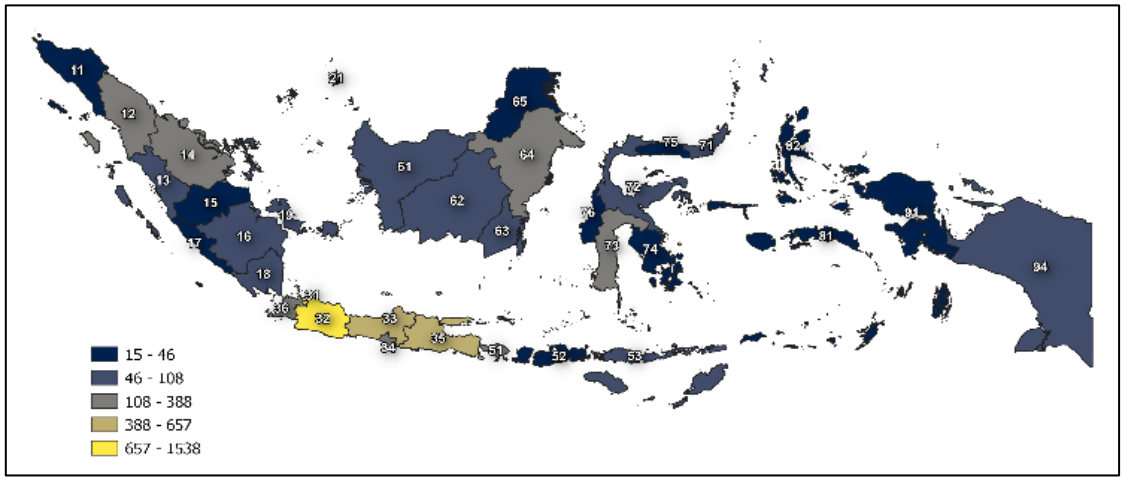


Figure 4. Indonesia's provincial underemployment rate, 2020–2022

Covid-19 cases in Indonesia's provinces on the island of Java tend to be higher than in provinces outside Java. Figure 5 illustrates the average daily distribution of Covid-19 cases in Indonesia in 2022. On the island of Java, the average daily provincial Covid-19 cases typically fall within the moderate to very high category, whereas provinces outside Java generally to fall in the moderate to very low category. The provinces of DKI Jakarta and West Java are notable for being provinces with a very high category of Covid-19 cases. Given that Covid-19 is transmitted through close contact, it can spread more rapidly in DKI Jakarta and Jawa Barat, as they are the two most populous provinces in Indonesia. Both 2020 and 2021, the population density in DKI Jakarta exceeded 15,900 people per km^2 , while in West Java is surpassed 1,300 people per km^2 (Badan Pusat Statistik, 2023).



Note: Numbers on the map represent IDs (Appendix 1)

Figure 5. Indonesia's average provincial daily Covid-19 cases, 2020–2022

In 2020, population mobility is negative, indicating a decrease compared to the period before the Covid-19 pandemic. Bali experiences the highest decrease in population mobility, while Nusa Tenggara Timur has the lowest decrease. Population mobility in Bali remains lower than before the pandemic in both 2020 and 2022. This decline is particularly pronounced in Bali due to its heavy reliance on the tourism sector. During the Covid-19 pandemic, non-essential visits and distance travel decreased (Engle *et al*., 2020; Moreno-Luna *et al*., 2021). Many individuals refrained from traveling due to concerns about contracting Covid-19 or because of lockdown policies.

There is an increase in population mobility in 2022 compared to 2020 (see Figure 6). On the other hand, population mobility tends to be positive in 2022 for most provinces indicating an increase in mobility compared to before the Covid-19 pandemic periods besides Bali, DKI Jakarta, and Riau Islands. The lockdown measures have significantly impacted economic activity. DKI Jakarta, being the economic center, experienced very high population mobility before the pandemic. In addition, the population mobility of Riau Islands, as one of the gates for international trade in Indonesia, is also lower compared to the period of before the Covid-19 pandemic. Based on Nwokolo *et al*. (2020), trade between countries was partly shut down due to the lockdown policies. In general, provincial economic growth in Indonesia increase from 2020 to 2022. Provincial economic growth experience a sharp increase in 2021, transitioning from negative to positive values for 29 provinces. Figure 6 illustrates Indonesia's provincial economic growth from 2020 to 2022.

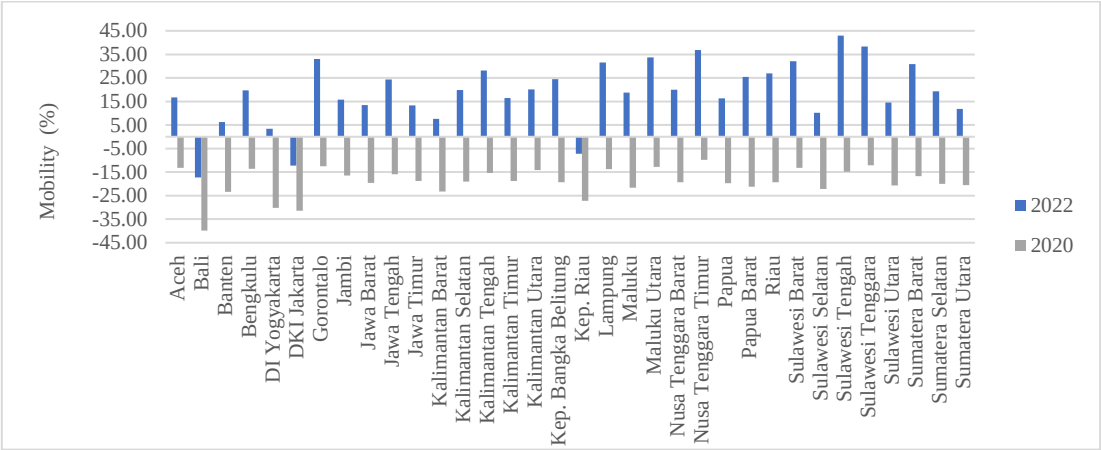


Figure 6. Indonesia's provincial population mobility in 2020 and 2022.

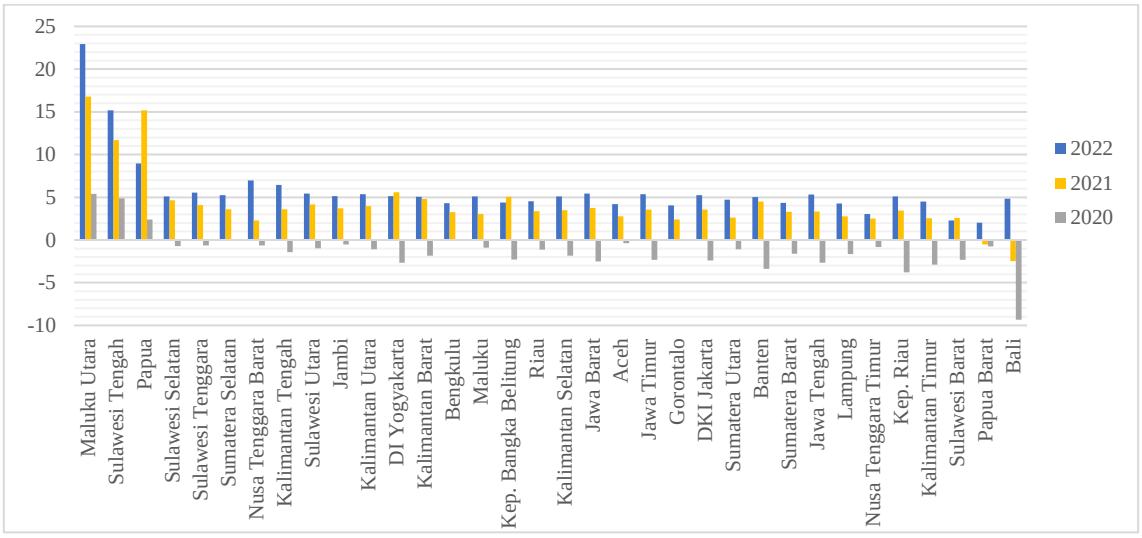


Figure 7. Indonesia's provincial economic growth, 2020–2022.

Maluku Utara is the province with the highest economic growth from 2020 to 2022, while Bali is the province with the lowest economic growth in 2020 and 2021. Maluku Utara, Sulawesi Tengah, and Papua are the three provinces with the highest economic growth during period of 2020-2022, despite other provinces experiencing negative economic growth in 2022 (refer to Figure 7). These three provinces share a common characteristic: their economies are supported by the mining and manufacturing sectors. The imposition of a nickel ore export ban in 2020 may have contributed to the high economic growth of Maluku Utara and Sulawesi Tengah, as they are nickel exporting provinces. According to the Ministry of Communication and Information (2022), the imposition of a nickel ore export ban policy significantly increased the value of Indonesia's nickel exports to 326 trillion rupiahs or 20.9 billion USD in 2021, a 19 fold increase compared to 2014.

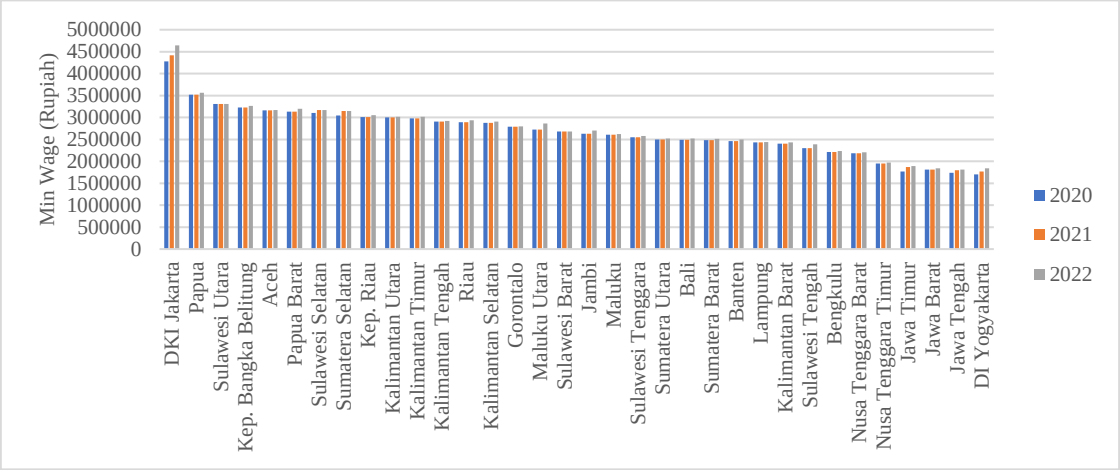
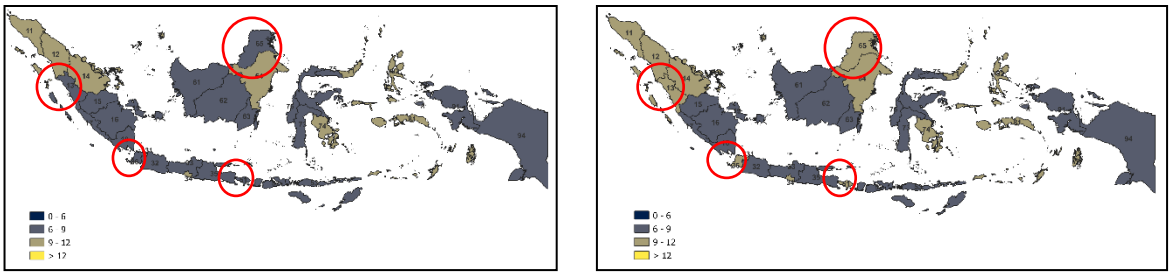


Figure 8. Indonesia's provincial minimum wage, 2020–2022.

The provincial minimum wage in Indonesia exhibits significant inequality, particularly in DKI Jakarta. According to Figure 8, DKI Jakarta has consistently had the highest average minimum wage from 2020 to 2022, while DI Yogyakarta has had the lowest. DKI Jakarta stands out as the only province with a minimum wage exceeding IDR 4 million. In 2022, the minimum wage in DKI Jakarta reached IDR 4,641,854.00, whereas in DI Yogyakarta, it was IDR 1,840,916.00. This represents a substantial difference of 2.8 million rupiahs between the lowest and highest provincial minimum wages.



(a) (b)

Figure 9. (**a**) Indonesia's provincial mean years schooling in 2020; (**b**) Indonesia's provincial mean years schooling in 2022.

The MYS for the Indonesian population in 2020 and 2022 tends to fall within the 6-9 years category, equivalent to junior high school education. Figure 9 illustrates the provincial MYS in Indonesia for both 2020 and 2022. The figure indicates that provinces on the islands of Java and Papua predominantly fall within the 6-9 years MYS category in both 2020 and 2022. However, four provinces (Bali, Kalimantan Utara, Sumatra Utara, and Banten) transitioned from the 6–9 years MYS category (equivalent to junior high school) in 2020 to the 9–12 years MYS category (equivalent to senior high school) in 2022. This increase in mean years of schooling may be attributed to the implementation of the 12-year compulsory education policy in Indonesia.

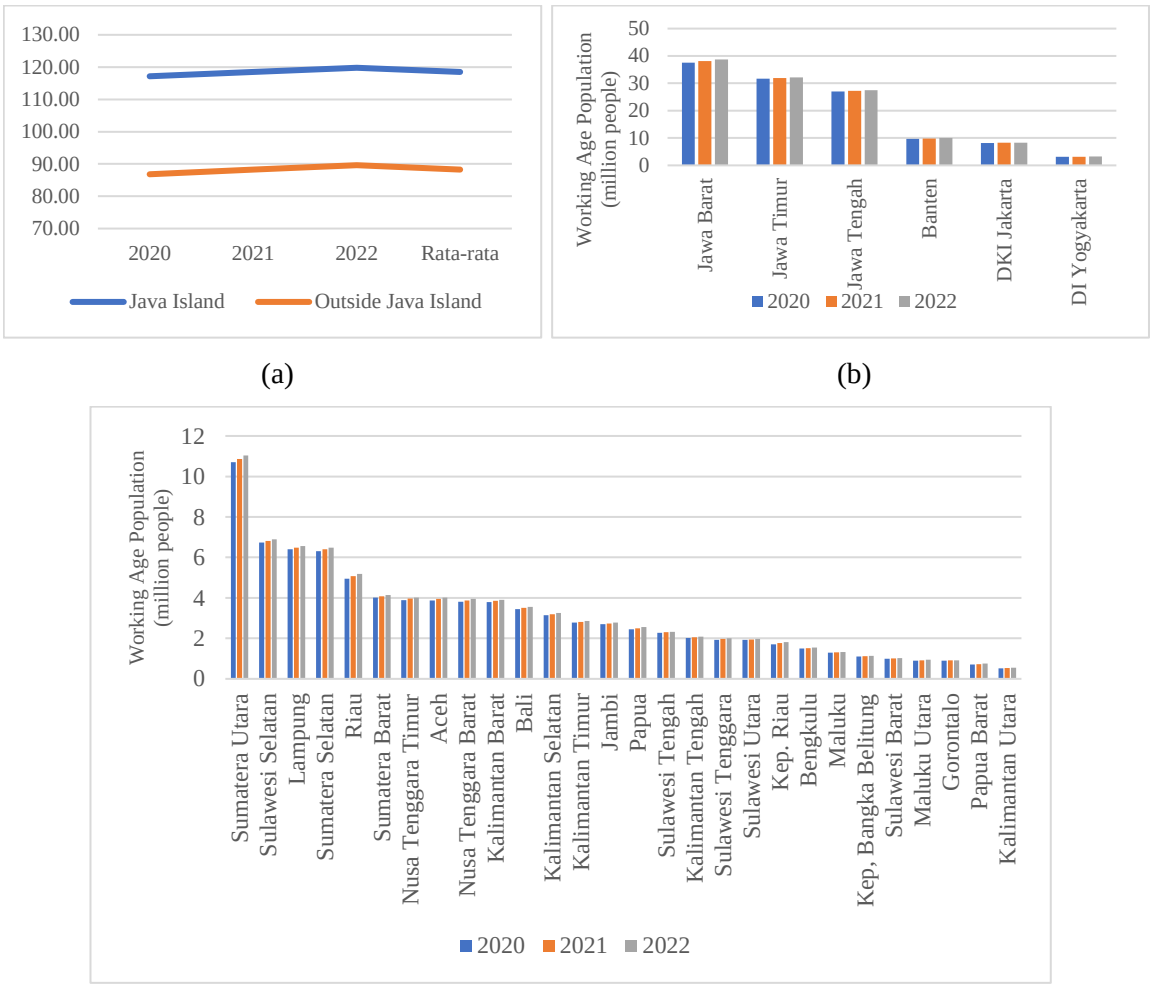


Figure 10. (a) Number of provincial working age population in Java Island (blue line) and outside Java Island (orange line), in 2020–2022; (b) Number of provincial working age population in Java Island, 2020–2022; (c) Number of provincial working age population outside Java Island, 2020–2022.

In general, the working-age population increased during the 2020–2022 period. Figure 10(a) depicts the development of the working-age population on the island of Java and outside Java during this time frame. Notably, the working-age population in the provinces of Java consistently exceeds that of provinces outside Java throughout the 2020–2022 period. Figure 10(b) highlights that Jawa Barat, Jawa Timur, and Tengah, the three largest provinces on Java Island, have the highest working-age populations, with Jawa Tengah leading the count. Conversely, DI Yogyakarta registers the lowest working-age population among Java provinces. The province with the lowest working-age population is DI Yogyakarta. On the other hand, Figure 10(c) illustrates that Sumatra Utara, outside Java Island, boasts the highest working-age population, surpassing 8 million people. In contrast, Kalimantan Utara has the lowest working-age population among provinces outside Java.

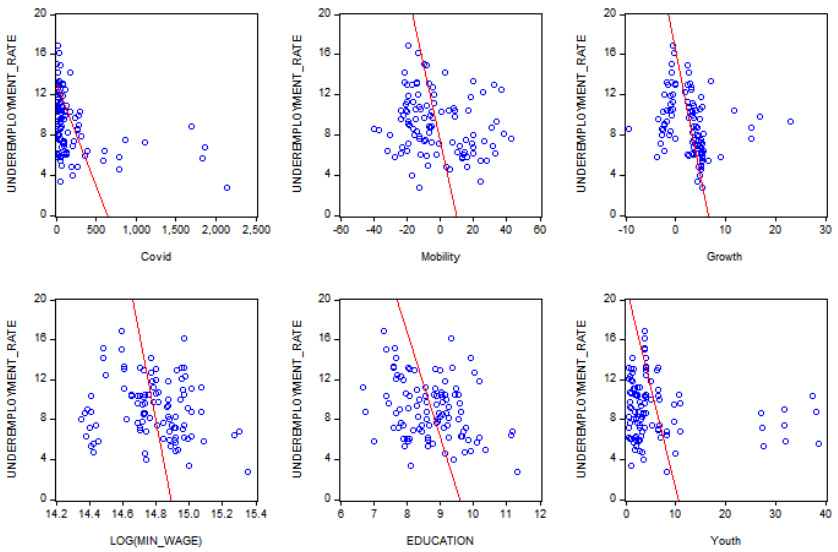


Figure 11. The relationship between the dependent variable and independent variables.

The Chow test was carried out and a *p-value* = 0.000 < α= 0.05 was obtained. It means the Fiexed Effect Model (FEM) is better than the Common Effect Model (CEM). Then, the Hausman test was conducted and we got the *p-value* = 0.0326 < α= 0.05 which means that FEM is better than REM. So, the best model is FEM. Examining the residual variance-covariance matrix structure is carried out if the best model chosen is the FEM. The value of Lagrange Multiplier (LM) = 116,693 > $\chi^2_{0.05,33}$= 47,400 was obtained which means the residual variance-covariance matrix is heteroscedastic. Because the residual variance-covariance matrix is heteroscedastic, we did a λ_{LM} test. The test result shows λ_{LM}= 2254,693 > $\chi^2_{0.05,561}$= 617,693 which means the residual variance-covariance matrix structure has a cross-sectional correlation. Thus, the best model for this study is the FEM with the Feasible Generalized Least Square-Seemingly Uncorrelated Regression (FGLS-SUR) estimation method which can accommodate heteroscedasticity and autocorrelation (Greene, 2012).

The normality test was carried out by the Anderson-Darling test with *p-value* = 0.1342 > α= 0.05 means the residuals are normally distributed (the normality assumption is met). Testing the non-multicollinearity assumption is carried out by looking at the correlation between the independent variables. Based on the test results, all combinations of independent variables correlate below 0.8 which means that there is no multicollinearity in the model (Gujarati & Porter, 2009).

Based on Table 2, the F-statistic value = 127.8392 < α= 0.05 so there is sufficient evidence that six independent variables together have a significant effect on the underemployment rate. The FGLS-SUR model shows an adjusted R-squared value of 0.9799, which means that the six independent variables explain about 97.99 percent of the underemployment rate, while the remaining 2.01 percent is explained by other variables outside the model.

Table 2. Parameter estimation results

Independent: The Underemployment Rate

Variable	Coefficient	Statistical t-test	Prob
(1)	(2)	(3)	(4)
C	172.1707	9.4315	0.0000***
Covid-19	0.0004	0.5693	0.5712
Mobility	-0.0409	-7.6013	0.0000***
EcoGrowth	-0.0869	-2.5169	0.0144**
Wage	-8.5625	-7.6838	0.0000***

Education	-2.3390	-4.7132	0.0000***
Population	-2.6301	-3.1046	0.0029***
Statistical Summary			
R-Squared	0.9877	F-test	127.8392
Adjusted R-Square	0.9799	Prob	0.0000

*** p < 0.01, ** p < 0.05, * p < 0.1

Based on Table 2, variables such as mobility, economic growth, minimum wage, education, and the working-age population have a significant negative effect on the underemployment rate. In contrast, Covid-19 exhibits a positive but non-significant effect on the underemployment rate. The positive relationship between Covid-19 cases and the unemployment rate aligns with findings from previous studies (Aum *et al*., 2020; Beland *et al*., 2020; Chen *et al*., 2020; Katris, 2021; Sjoquist & Wheeler, 2021; Su *et al*., 2022). Sjoquist & Wheeler (2021) argue that the insignificant impact of Covid-19 on unemployment is attributed to its marginal effect on the unemployment rate, particularly when Covid-19 cases are low. The Covid-19 pandemic has disrupted the way many people work and increased the share of people working from home (Arntz *et al*., 2020). The implementation of Work From Home (WFH) policies by many companies could be a contributing factor to the relatively low number of Covid-19 cases reported. When companies adopt WFH policies, employees who are infected with Covid-19 or fear contracting the virus may choose to self-quarantine without completely ceasing work. According to Badan Pusat Statistik (2020a) in July 2020, 5.45 percent of companies implemented WFH for some employees, while 2.05 percent of companies implemented WFH for all employees. By October 2020, the adoption of WFH policies had further increased, with 8.71 percent of companies implementing WFH for some employees and 4.63 percent implementing WFH for all employees (Badan Pusat Statistik, 2020b).

The coefficient of mobility, which is -0.0409 indicates that when the average population mobility increases by 1 percent from the baseline, the average underemployment rate will decrease by 0.0409 percent points, assuming all other factors remain constant (ceteris paribus). This phenomenon can occur because an increase in mobility often facilitates economic activity. The rise in population mobility suggests a concurrent increase in consumption. As people move around, they incur expenses on transportation, fuel, driver services, and various other goods and services. This, in turn, boosts aggregate demand in the economy. This result is consistent with findings from studies conducted by Chen *et al*. (2020), Haldar & Sethi (2022), Ngo *et al*. (2022), and Heemann Utz *et al*. (2022), all of which suggest that increasing population mobility or easing mobility restrictions can lead to reduction in unemployment or an increase in individual's working hour.

The coefficient of cconomic growth, which is -0.0869, suggests that when the average economic growth increases by 1 percent, the average underemployment rate is expected to decrease by 0.0869 percentage points, assuming all other factors remain constant (ceteris paribus). This finding aligns with Okun's law, which posits a negative relationship between unemployment and GDP growth. According to Mankiw (2022), economic growth has the potential to create jobs, supporting the observed negative relationship between economic growth and underemployment. Economic growth occurs as a result of increased demand and supply in the economy. When demand for goods and services rises, companies respond by hiring more workers or increasing the working hours of existing employees. This allows them to ramp up their production to meet the growing demand. The results of this study are in line with research by Mahadika & Wibowo (2021), Mahendra & Parulian (2021), Rokhim *et al.* (2023), and Soylu *et al.* (2018) who similarly found out that increasing economic growth will be accompanied by a decrease in unemployment. This research is consistent with the findings of Pratomo (2015) who demonstrated that Gross Regional Domestic Product (GRDP) has a negative effect on underemployment.

The minimum wage variable exhibits a significant negative effect on the underemployment rate, with a regression coefficient of -8.5625. This suggest that when the minimum wage increases by 1 percent, the underemployment rate will decrease by 0.0856 percent, assuming *cateris paribus*. This research is consistent with the findings by Beland *et al*. (2020) and Rokhim *et al*. (2023). Rokhim *et al*. (2023) suggest that an increase in wages can lead to a decrease in unemployment by boosting people's purchasing power, thereby stimulating aggregate demand. Another potential outcome is that wage increases can create opportunities for workers to invest in other businesses using the additional capital from their wages. This entrepreneurial activity can lead to increased demand for labor as new businesses require additional workers to operate effectively. In addition, Beland *et al*. (2020) found that that workers with greater exposure to Covid-19 were more likely to experience Covid-19-related unemployment. Interestingly, some workers who faced higher exposure received wage increases. This suggest that wage increase can incentivize individuals to work or increase their working hours, thereby reducing both unemployment and underemployment rates.

Low-skilled or low-educated workers were the ones who suffered the most during the pandemic (Mack *et al*., 2021; Marcén & Morales, 2021; Mekonnen & Amede, 2022; Su *et al*., 2022; Zieliński, 2022). The pandemic could lead to an increase in demand for healthcare workers, which is required high-level education, to help face the crisis (Beland et al., 2020). On the other side, amidst the various limitations imposed by the Covid-19 pandemic lockdown, Information and Communication Technology (ICT) emerge as a crucial channel for communities to sustain their activities. Garfin (2020) noted that people's relience on technology has increased during the pandemic. This increased dependence on technology is speculated to be one of the reasons why education significantly reduces the underemployment rate, as evidenced by a regression coefficient of -2.3390. This coefficient indicates that for every additional year of education, the underemployment rate is expected to decrease by 2.3390 percentage points, assuming all other factors remain constant (ceteris paribus). The results of this study align with previous research conducted by Muin (2020) and Rosca & Teposu (2018) which suggest that an increase in education can lead to the reduction in unemployment. Additionally, Stofkova *et al*., (2022) emphasize the importance of ICT skills in facilitating success in the labor market. Goldin (2016) argues that there is a continuous interplay between the supply of skills and the demand for skills, with education serving as an equilibrium. Provinces with higher levels of education are better positioned to access jobs that leverage technology, leading to lower underemployment rates.

The limitations imposed by the pandemic, coupled with the increasing dependence on technology, have accelerated the adoption of flexible work arrangements and telecommuting (Beland *et al*., 2020). The working-age population variable exhibits a significant negative effect on the underemployment rate, with a regression coefficient of -2.6301. This suggests that when the working-age population increases by one million people, the underemployment rate is expected to decrease by 2.6301 percentage points, assuming all other factors remain constant (ceteris paribus). A decrease in the underemployment rate can be attributed to several factors associated with an increase in the working-age population. he urge to work can be driven by concerns about job security, as highlighted by Begum *et al*. (2022) who noted that job insecurity is associated with an increase in working hours. Several studies, including by those Gómez-Domínguez *et al*., (2023) and Sun *et al*., (2022). For instance, a survey conducted by Jobvite (2020), found that 47 percent of workers in the United States are express concerns about losing their jobs compared to before the pandemic. This fear of job loss motivates workers to increase their working hours or actively seek new job opportunities. Moreover, employment opportunities in Indonesia have shown a tendency to increase from 2020 to 2022, as indicated by the rise in the Employment to Population Ratio (EPR) during this period

(Badan Pusat Statistik, 2021c, 2022). During the Covid-19 pandemic, changes in people's living arrangements have spurred the emergence of new business opportunities (Batool *et al*., 2021). One of the sectors that experienced growth during the pandemic is e-commerce. According to the E-Commerce survey, the percentage of businesses engaged in e-commerce saw a notable increase. Specifically, as of December 31 in 2020 was 25.25 percent of business were conducting e-commerce, while in 2021, this figure rose to 32.23 percent (Badan Pusat Statistik, 2021e).

CONCLUSION

The underemployment rate and Covid-19 cases have shown a decreasing trend during the 2020-2022 period. On the other hand, population mobility, economic growth, minimum wages, education, and the working-age population have all increased. An increase in population mobility has been associated with a significant reduction in the underemployment rate. Interestingly, the increase in Covid-19 cases does not appear to have a significant impact on the underemployment rate. This may be attributed to various policies that allow workers to maintain their working hours even if they are infected with Covid-19 or fear infection. Furthermore, increases in other socioeconomic variables, namely economic growth, minimum wages, education, and the working-age population, have also been linked to a significant reduction in the underemployment rate. Economic growth, increasing mobility, rising population wages, and the expansion of online employment, such as e-commerce, have all contributed to job creation, allowing individuals to increase their working hours. Moreover, higher wages can incentivize individuals to work even in sectors vulnerable to Covid-19. Additionally, ICT skills acquired through education enable workers to adopt more flexible work arrangements. Furthermore, the increase in the working-age population, coupled with an expansion in employment opportunities, has led to a reduction in the underemployment rate.

The significant influence of population mobility and the insignificant impact of Covid-19 cases highlights the crucial role of government in shaping mobility restriction policies. Caution is necessary in policy-making to ensure effective management of mobility while minimizing negative impacts on employment. Increasing people's income through wages can be effective in reducing the underemployment rate. However, raising the minimum wage is considered risky, especially in unstable economic conditions, as it may strain companies. Income subsidies and tax cuts are viewed as viable options for boosting workers' purchasing power without excessively burdening businesses. Borjas (2013) suggests that subsidies and tax cuts can stimulate employment and raise workers' salaries. Furthermore, promoting e-business and e-commerce can create opportunities for remote work, while enhancing education and skills, particularly in information and communication technology, can be instrumental in reducing the underemployment rate, especially in the event of future lockdowns.

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