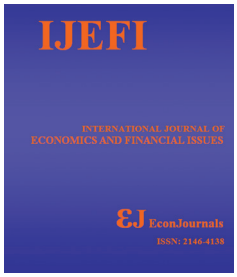

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Climate Change and Cyclical Unemployment in Indonesia

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ABSTRACT

Cyclical unemployment can transform into a permanent scar in the long term. Meanwhile, climate change is known to be systemic and has a long-term impact. Therefore, this research will investigate the effect of climate change on cyclical unemployment and analyze the potential for hysteresis. In the first stage, we will estimate cyclical unemployment using the Philips curve concept. The data employed is secondary data from Statistics Indonesia, which is processed using the simultaneous equation method. The results show that warming temperatures do not affect cyclical unemployment directly. However, the decrease in economic growth caused by the warming temperature can increase cyclical unemployment. These results also indicate the occurrence of hysteresis in Indonesia.

Keywords: Cyclical Unemployment, Inflation, Climate Change, Economic Growth, Hysteresis, Monetary Policy
JEL Classifications: E24, E31, E32, Q54

1. INTRODUCTION

Cyclical unemployment is often considered a short-term problem that can be immediately covered through expansive aggregate demand policies (Martín-Román et al., 2023). However, the duration of the disinflation policy (one of the causes of economic downturn in the short-run) carried out by the monetary authority will also greatly determine the existence of cyclical unemployment. Disinflation over a long period means that cyclical unemployment also has to wait longer to be able to return to work.

An individual who is jobless for too long will lose their skills and ability to return to work (Darity and Goldsmith, 1996; Elsby et al., 2009). As a result, cyclical unemployment, which was initially considered only a temporary scar in the short term, can transform into a permanent scar in the long term and is one of the causes of higher unemployment rates in the future. This phenomenon is called hysteresis (Cerra et al., 2023; Handa, 2008; Kula and Aslan, 2014; O'Shaughnessy, 2011).

Meanwhile, it is worried that climate change, which is known to be systemic and has long-term impacts, will increase the possibility of hysteresis (Babiker and Eckaus, 2007; ILO, 2018; Kahn et al., 2021). Climate change, such as warming temperatures, can make workers less productive due to limited working hours and health problems (physical risks) (Batten et al., 2020). As a result, workers become increasingly vulnerable to being laid off, especially in economic downturns, and have difficulty finding work immediately in economic upturns.

Warming temperatures will also disrupt economic activities in several sectors highly dependent on natural conditions, such as agriculture, fisheries, forestry and tourism (Dell et al., 2012; ILO, 2018; Olivier and Greenstone, 2007; Taher, 2019). Climate mitigation policies will also limit the industrial sector activities (Babiker and Eckaus, 2007; Batten et al., 2020). Disruption of economic activity in both cases will increase cyclical unemployment during economic downturns and slow the recovery process, which means cyclical unemployment will have to wait longer to return to work. Therefore, climate change will affect

cyclical unemployment, both directly (its influence on labor productivity) and through its effect on economic activity, and once again, it also has the potential to produce permanent scars on cyclical unemployment.

It seems that policymakers in Indonesia are also facing similar challenges. According to the latest report from Statistics Indonesia (Figure 1), inflation fluctuated between 2012 and 2021 with a downward trend (4.3% in 2012 and 1.9% in 2021). During this period, inflation increased 4 times (in 2012, 2013, 2017 and 2021) and decreased 6 times (in 2014, 2015, 2016, 2018, 2019 and 2020). Disinflation occurred for 3 consecutive years on two occasions, indicating the duration of disinflation in this period was quite long and made it possible for cyclical unemployment to emerge for quite a long time.

Over the same period, the average temperature has remained relatively stable. However, there has been a slight increase in temperature from 26.9°C in 2012 to 27.1°C in 2021. Furthermore, the unemployment rate has increased from 6.1% in 2012 to 6.5% in 2021, while economic growth has decreased from 6% in 2012 to 3.7% in 2021. These facts, especially related to an increase in the unemployment rate, raise concerns about the occurrence of hysteresis. Therefore, policymakers should conduct a detailed analysis of cyclical unemployment determinants down to the provincial level in Indonesia when making decisions on monetary and climate policies.

As is well known, cyclical unemployment is not directly observable. Precise estimates are then needed to measure it. Several previous studies agree that cyclical unemployment can be estimated by subtracting the actual unemployment rate from the natural rate of unemployment or the Non-Accelerating Inflation Rate of Unemployment (NAIRU) (Martín-Román et al., 2023). This research will also use a similar approach but with a simple method, especially in estimating the NAIRU. The NAIRU estimation used in this research refers to the context of the Phillips Curve, which defines the natural rate of unemployment as the rate of unemployment consistent with constant inflation and establishes no differences between the natural rate of unemployment and NAIRU (Blanchard and Katz, 1997; Yunus et al., 2017; Zhang, 2005).

Finally, it would be beneficial for policymakers in Indonesia, especially the monetary authority, to have estimates of cyclical unemployment and analyze how climate change affects it. These estimates can serve as an indicator to evaluate the primary monetary policy objective of maintaining low and stable inflation. Meanwhile, analyzing the impact of climate change on cyclical unemployment can serve as an evaluation tool for stakeholders to support a green economy (Fried, 2018; Jadoon et al., 2021; Khobai et al., 2020; Shah et al., 2023).

It should be stressed that previous similar studies have not considered the aspect of unemployment in analyzing the relationship between climate change and price stability policy (Batten et al., 2020). Apart from that, other research for the case of Indonesia only focuses on the influence of aggregate demand and aggregate supply policies on excess unemployment from its NAIRU (Yunus et al., 2017). Therefore, this study is also a study that is still very rare.

2. MATERIALS AND METHODS

All data in this research was obtained from Statistics Indonesia. This research uses panel data on 29 provinces in Indonesia in the period 2012-2021. The use of only 29 provinces instead of 34 provinces in Indonesia is due to incomplete data on average temperature in 5 provinces (Kalimantan Utara, Nusa Tenggara Barat, Sulawesi Tenggara, Maluku and Maluku Utara). Meanwhile, observations over 10 years were carried out to anticipate long-term effects caused by cyclical cases (Cerra et al., 2023). In the initial stage, an estimate of cyclical unemployment will first be carried out using inflation and unemployment data.

Estimation of cyclical unemployment is carried out by calculating the difference between the fitted value of unemployment and the NAIRU, as shown in the following equation:

$$UCY_{it} = UFV_{it} - UNA \quad (1)$$

Where UCY_{it} is the cyclical unemployment in province i at year t; UFV_{it} is the fitted value of unemployment for each province i at year t and UNA is the NAIRU in 29 provinces in the period 2012-2021. Equation (1) refers to the cyclical unemployment estimate calculated by Martín-Román et al. (2023). The difference is Martín-Román et al. (2023) uses the HP Filter, the QT decomposition and the BK Filter in calculating values similar to the fitted value of unemployment used in this research. Meanwhile, following the NAIRU characteristics previously calculated by Zhang (2005) and Yunus et al. (2017), this research will only use one NAIRU value in one observation period.

Figure 1: Macroeconomic indicators and average temperature in Indonesia (2012-2021)

By its definition, the NAIRU represents the level of unemployment that can be accepted while maintaining stable inflation (where the change in inflation equals zero). Therefore, to determine the fitted value of unemployment and the NAIRU, we need to estimate the constant and the slope of the Philips curve based on the following equation:

$$UNE_{it} = A_0 + A_1 DIN_{it} + \mu_{it} \quad (2)$$

Where UNE_{it} refers to the actual unemployment in province i at year t; DIN_{it} is the change in inflation in province i at year t; A_0 is a constant; A_1 is the slope of the Philips curve and μ_{it} is the error term in province i at year t. Equation (2) is regressed using the method of Ordinary Least Squares (OLS) with panel data. By entering the estimation results of the constant ($\widehat{A_0}$), the slope of the Phillips curve ($\widehat{A_1}$), and changes in inflation in province i at year t (DIN_{it}) into Equation (2), we will obtain the fitted value of unemployment ($\widehat{UNE_{it}} = UFV_{it}$). The estimation results of the constant ($\widehat{A_0}$) represent the NAIRU (UNA) or the unemployment rate when the change in inflation equals zero. Equations (1) and (2) can then be restated in the following equations:

$$UFV_{it} = UNA + \widehat{A_1} DIN_{it}$$

$$UFV_{it} - UNA = \widehat{A_1} DIN_{it}$$

$$UCY_{it} = \widehat{A_1} DIN_{it} \quad (3)$$

Because the slope of the Philips curve ($\widehat{A_1}$) is expected to be negative (trade-off between unemployment and change in inflation), the cyclical unemployment rate will be positive when the change in inflation is negative (inflation falls) and has the meaning of workers laid off. Meanwhile, cyclical unemployment will have a negative value when changes in inflation are positive (inflation rises) and means the workers are returning to work. If the total cyclical unemployment in the long term has a positive value, it raises suspicions of hysteresis. On the other hand, if the total of cyclical unemployment has a negative value, it confirms that the problem of cyclical unemployment is only temporary and has been addressed adequately.

Furthermore, the simultaneous equations used to analyze the main topic of this research are:

$$GRO_{it} = \alpha_0 + \alpha_1 TEM_{it} + \mu_{1it} \quad (4)$$

$$UCY_{it} = \beta_0 + \beta_1 GRO_{it} + \beta_2 TEM_{it} + \mu_{2it} \quad (5)$$

Where UCY_{it} is measured in percent; GRO_{it} is the economic growth in province i at year t, measured in percent; TEM_{it} is the average temperature in province i at year t, measured in degrees Celsius; α_0 and β_0 are the constants; α_1, β_1 and β_2 are the parameters to be estimated and μ_{1it} and μ_{2it} are the random error terms.

The reduced-form equations based on Equation (4) and (5) can be presented in the following equation:

$$UCY_{it} = \gamma_0 + \gamma_1 TEM_{it} + \mu_{12it} \quad (6)$$

Where γ_0 ($\beta_0 + \alpha_0\beta_1$) is a constant; γ_1 ($\beta_2 + \alpha_1\beta_1$) is the total effect of variable TEM_{it} to variable UCY_{it}, which consists of a direct effect of β_2 and an indirect effect through GRO_{it} of $\alpha_1\beta_1$ and μ_{12it} ($\mu_{2it} + \mu_{1it}\beta_1$) is the composite error term. To test the research hypothesis, we will use the method of OLS with panel data to estimate the direct and indirect effects of both average temperature and economic growth on cyclical unemployment. Using the reduced-form equation, we can identify the coefficients for these effects. The estimated results later indicate that increasing average temperatures due to climate change will reduce worker productivity and increase cyclical unemployment if the β_2 coefficient is significant and positive.

Meanwhile, if the coefficient $\alpha_1\beta_1$ is significant and positive, it indicates that an increase in average temperature will also disrupt economic activity and increase cyclical unemployment. These results make policymakers (monetary authorities, government and economic actors) need to increase economic activity that always follows the principles of sustainable development (green economy) (Jadoon et al., 2021; Khobai et al., 2020; Shah et al., 2023). Otherwise, if the coefficients are significant with the opposite sign or are not statistically significant at the 5% level, it suggests that climate change in the form of an increase in average temperature is already anticipated by policymakers. In this scenario, it is possible to resolve cyclical unemployment even in the short term.

3. RESULTS

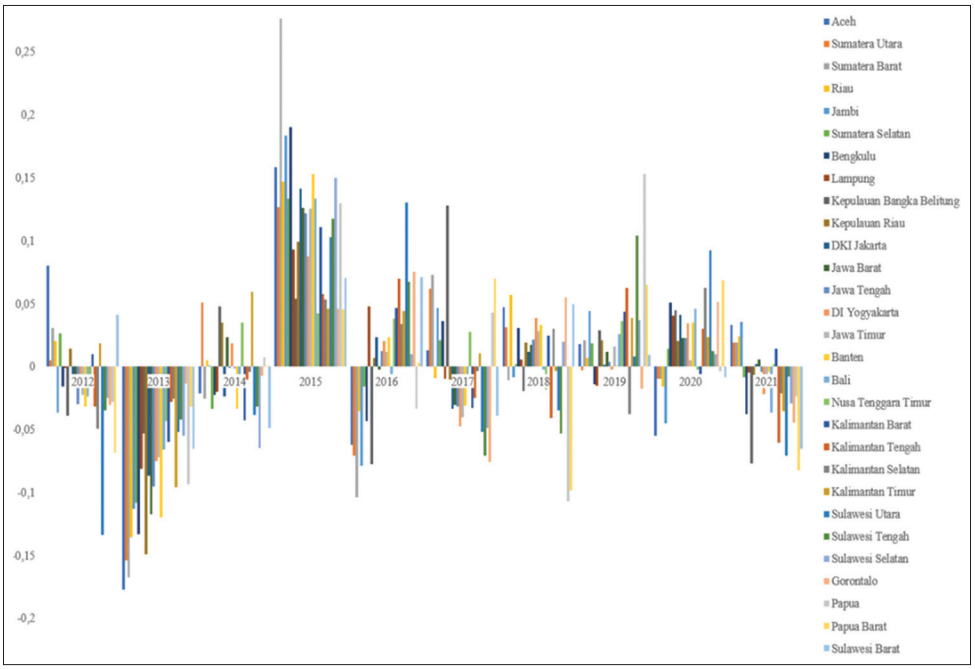
Figure 2 shows that the cyclical unemployment estimation in 29 provinces in Indonesia (2012-2021) recorded the lowest value at −0.18% (Aceh in 2013) and the highest at 0.28% (Sumatera Barat in 2015). It may also be noted that, in 2013, all 29 provinces had a negative value. Meanwhile, in 2015, all provinces had a positive value.

Overall, cyclical unemployment (year-to-year) in each province tends to decline. It suggests that monetary authorities have anticipated the short-term effects of control on inflation. However, the total cyclical unemployment over the research period, which has a positive value (1.21%), means that the number of laid-off workers was still higher than the number of re-employed workers. In other words, the short-term cyclical unemployment has not been fully absorbed in the long term, and the hysteresis phenomenon may be unavoidable in Indonesia.

It could be because the disinflation policy in the research period had a long duration, resulting in a longer waiting period for cyclical unemployment to get a job again. Here, workers who are unemployed for too long can lose the ability to return to work (Darity and Goldsmith, 1996; Elsby et al., 2009). Ultimately, there is some cyclical unemployment that has not been absorbed in the long term. The implication is that in controlling inflation, the monetary authority needs to pay attention to the duration of disinflation. Once again, the longer the duration of inflation, the longer the duration of cyclical unemployment.

Furthermore, the monetary authority should use the total magnitude of cyclical unemployment in the long term as an

Figure 2: Cyclical unemployment in 29 provinces in Indonesia (2012-2021) (%). A_0 UNA = NAIRU = 5.34%, the slope of Philips curve = −0.02 and the total cyclical unemployment (Aceh in 2012 to Sulawesi Barat in 2021) = 1.21%.



Source: Authors' calculation

indicator in evaluating maintaining and low inflation policies. Cyclical unemployment that remains in the long term indicates that monetary policy, especially disinflation, has an impact on unemployment even in the long term. In this way, the monetary authority can fulfill its primary responsibility of maintaining inflation stability while also contributing to the reduction of unemployment in the future.

The results of the primary model from this research are presented in Table 1. The low R^2 value of cyclical unemployment suggests that other variables besides average temperature and economic growth also affect cyclical unemployment. Similarly, the relatively low R^2 value of economic growth indicates that climate change is not the only factor that affects high or low economic growth. However, the probability F-statistic value of cyclical unemployment and economic growth, each of which is statistically significant at the 5% level, shows that each independent variable has a significant influence simultaneously so the model used in this research is still valid.

Table 2 served the direct, indirect and total effects of the exogenous variables (TEM_{it}) on the endogenous variables (UCY_{it}). The direct coefficient of the average temperature on cyclical unemployment is not statistically significant, with a probability value of 0.126. It means that any change in temperature does not directly affect any change in cyclical unemployment. This result is contrary to the initial expectations that climate change, in the form of increasing temperatures, would directly increase the number of cyclical unemployment. However, extreme weather events can still affect worker productivity, leading to physical risks (Batten et al., 2020).

The insignificant direct effect of climate change on cyclical unemployment in Indonesia is more due to the intensity of green building projects, which have continued to increase in recent years,

Table 1: Estimation results for Equation (4) and (5)

Directions of Effect	Coefficients	t-Statistic	Probability
$TEM_{it} \rightarrow GRO_{it}$	−0.441*	−2.407	0.017
$GRO_{it} \rightarrow UCY_{it}$	−0.003*	−2.468	0.014
$TEM_{it} \rightarrow UCY_{it}$	0.005	1.534	0.126

*Significant at 5% level. R-squared GRO_{it} =0.020; R-squared UCY_{it}=0.033; N=290. Probability (F-statistic) GRO_{it}=0.017. Probability (F-statistic) UCY_{it} =0.008. Source: Authors' calculation

Table 2: Direct, indirect and total effect

Directions of effect	Coefficients		
	Direct effect	Indirect effect	Total effect
$TEM_{it} \rightarrow UCY_{it}$ (γ_1)	0.005		0.006
Through $\rightarrow GRO_{it}$		0.001*	
$TEM_{it} \rightarrow GRO_{it}$	−0.441*		−0.441*

*Significant at 5% level. Source: Table 1

especially after the COVID-19 pandemic. The green building projects are a form of government awareness in responding to climate anomalies (Fried, 2018; Khodadadzadeh, 2016). The presence of these new projects certainly gives hope for the cyclical unemployment to be able to find work again.

In addition, these findings also suggest that the workers in Indonesia are successfully adapting to climate change. Once again, the COVID-19 pandemic has provided its own blessing. Here, COVID-19 has increased the awareness of the government and workers regarding the importance of synergy between economic activities and environmental sustainability. The hope is that in the future, this synergy can encourage transformation towards a green economy, which can then have an impact on the sustainability of the development in the long term. In this way, the risk of hysteresis in cyclical unemployment can be minimized.

The implication is that the monetary authority in Indonesia needs to increase the portion of green financing to support the development of green building projects, which are known to create new jobs (Khodadadzadeh, 2016; Shah et al., 2023). In this way, the monetary authority can be a transformation catalyst towards a green economy while also contributing to the reduction of cyclical unemployment in the long term. Meanwhile, economic actors must constantly adapt to climate change, for example, regarding energy use, which always follows the principles of sustainable development (Akpan and Akpan, 2011; Levinson, 2016).

Furthermore, the indirect coefficient of average temperature on cyclical unemployment through economic growth is positive and statistically significant. It comes from a negative and significant relationship (probability value of 0.017 and coefficient value of −0.441) between average temperature and economic growth, which continues with a negative and significant relationship (probability value of 0.014 and coefficient value of −0.003) between economic growth and cyclical unemployment. It means a rise in average temperature by 1°C will reduce economic growth by 0.441%. This decrease in economic growth will then increase cyclical unemployment by 0.001 (−0.441 times −0.003) percent. On the other hand, a decline in average temperature by 1°C will raise economic growth by 0.441%. This increase in economic growth will then reduce cyclical unemployment by 0.001%. This result is to the initial expectations, which stated that climate change, in the form of warming temperatures, indirectly affects cyclical unemployment through its impact on economic growth.

The implication is that the monetary authority should increase financing in several sectors highly dependent on natural conditions, such as agriculture, fisheries, forestry and tourism. The decline in productivity in these sectors due to extreme temperatures will reduce the demand for new workers and lengthen the waiting period for cyclical unemployment to return to work.

A similar financing approach can be applied to the industrial sector. As it is known, the productivity of the industrial sector can also be disrupted by climate mitigation policies (transition risks) (Batten et al., 2020; Jadoon et al., 2021). However, in providing financing to the industrial sector, the monetary authority needs to consider the environmental impact produced by the industrial sector or, in other words, greening the debtors that operate in the industrial sector. It will create economic growth consistent with environmental sustainability and can ensure sustainable development. Finally, long-term problems such as permanent cyclical unemployment can resolved.

4. CONCLUSION

Climate change does not affect cyclical unemployment directly due to the presence of green building projects. The fact that the workers have been successfully adapting to any change in the climate is also the cause of the results. It makes the monetary authority in Indonesia need to increase the portion of green financing. Meanwhile, the decrease in economic growth caused by the warming temperature will increase cyclical unemployment. Here, the monetary authority should add finance in several sectors highly dependent on natural conditions, such as agriculture, fisheries, forestry and tourism. A similar financing approach can be applied to the industrial sector. However, in providing financing to the industrial sector, the monetary authority needs to green the debtors that operate in the industrial sector. Finally, even though monetary authorities have anticipated the short-term effects of control on inflation, hysteresis is still unavoidable.

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