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# The Impact of Interest Rate Spillover on Output Gap: A Dynamic Spatial Durbin Model

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**Abstract:** The recent multidimensional crisis has harmed the global economy because countries are currently integrated. In this study, we examine the spillover effect of the United States (US) interest rate on the output gap of ASEAN+3 countries using the dynamic spatial Durbin model from 2010 to 2020. After controlling for various institutional variables, this analysis further examines the effect of the exchange rate and the COVID-19 pandemic on the output gap. This model captures the spatial interactions and short- and long-term effects of interest rate monetary policies. The findings indicate a negative spillover effect of the US central bank interest rate on ASEAN+3 countries' output gap. The result had significant direct and indirect short-term effects. Additionally, exchange rates negatively affect the output gap. The output gap decreased because of the COVID-19 pandemic. This study is expected to be useful for monetary authorities in developing the best monetary policy for economic recovery.

**Keywords:** interest rate; spillover effect; output gap; exchange rate; COVID-19 pandemic; dynamic spatial Durbin model

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## 1. Introduction

The economic shock triggered by the COVID-19 pandemic and the geopolitical crisis caused uncertainty and weakened the global economy. The pandemic has resulted in a decline in economic growth and stagflation (Baldwin and Mauro 2020; Meier and Pinto 2020). Social distancing or lockdown policies in several countries during the pandemic have reduced economic and trade activities owing to the disruption of global supply chains (Baldwin and Mauro 2020; Krista et al. 2020; Vidya and Prabheesh 2020; Wuri et al. 2022; Ing and Vadila 2022). Governments and monetary authorities worldwide are coordinating policies to restore the economic conditions affected by external shocks. Most previous studies in many countries have indicated that coordination is better than isolation (Baldwin and Mauro 2020; Utama et al. 2022).

The study of monetary policy is essential because its precision affects the economy nationally and globally. A new macroeconomic perspective suggests that a contractive interest rate monetary policy can reduce the output gap, policy uncertainty, and persistent labor market challenges, further threatening the achievement of sustainable economic development. Conversely, a government's efforts to maintain a relatively low interest rate can strengthen the national economy (Blanchard 2019; Hubbard et al. 2014; Tian et al. 2023).

One of the most important developments over the past few decades has been the spread of economic policies worldwide. The literature has shown a tendency for monetary policies determined by the world's leading countries to have a spillover effect on countries in the regions that are closely related (Ezcurra and Rios 2015; Georgiadis 2016; Iacoviello and Navarro 2019; Miranda-Agrippino and Rey 2020). However, the spillover effect of interest rates on a country's output gap is yet to be widely studied (Cota et al. 2017; Tian

et al. 2023). Research on spillover effects mainly focuses on foreign exchange rates, FDI, and financial markets (Albagli et al. 2019; Blasques et al. 2016; Dimitriou et al. 2017; Eck and Huber 2016; Fasanya et al. 2021; Huang and Zhang 2020; Tian et al. 2023). Academics and policymakers continue to discuss how interest rate spillovers affect the output gap.

The increase in a country's output gap is not only influenced by the government's monetary policy but also by the monetary policy implemented by the monetary authorities of the world's leading countries. In this case, policies are spatially interdependent among the countries (Bhattarai et al. 2020; Georgiadis 2016; Iacoviello and Navarro 2019; Ntshangase et al. 2023; Tian et al. 2023). The United States (US) central bank's interest rate policy, the Federal Reserve (Fed), affects the global economy (Iacoviello and Navarro 2019; X. Tang 2022; Ntshangase et al. 2023; Utama et al. 2022). The Fed's tightening of the Federal Fund Rate (FFR) caused an interest rate differential between countries. This condition will encourage risk-off global investor behavior, reversing capital flows to the United States to earn higher returns on capital than in ASEAN+3 countries (Koepke 2018).

The dynamics of interest rate policy are illustrated in new macroeconomic theory. The Federal Reserve's decision to lower interest rates has the potential to stimulate inflation and represent bad news for the economy. In addition, the rate reductions increased capital outflows. Investors will shift their assets to other countries with stable economies to earn higher returns. Conversely, if the Fed raises interest rates, it will encourage capital inflows to America and cause appreciation in the US dollar. The rate increased by the Fed could reduce investment attractiveness in ASEAN+3 countries since global investors prefer to invest in the US, which offers higher yields. This circumstance may impede economic growth and lead to lower output than potential (Bräuning and Sheremirov 2019; Ciminelli et al. 2022). Because of the spillover effects, an increase in interest rates in the United States may result in a global rate hike, including in ASEAN+3 countries. This can lead to higher borrowing costs, strain state budgets and the private sector, and destabilize the economy. More expensive loans could affect public and corporate credit access. This circumstance will restrict domestic consumption and investment, perhaps reducing the output gap (Spiegel 2022).

The emergence of the COVID-19 epidemic caused a significant and long-lasting fall in world output, with outcomes being quite heterogeneous across countries and regions. No country was immune to the economic fallout of the pandemic because of global interconnections. This situation encouraged the Fed to conduct monetary expansion, which was followed by the ASEAN+3 countries (Chong et al. 2021; Feldkircher et al. 2021). The effort is expected to increase the output gap and improve economic circumstances (Aziz et al. 2022; Chudik et al. 2021; Nguyen et al. 2022).

Given the scarcity of studies on the dynamic spatial dependency model of monetary policy, this study complements the literature by analyzing the dependence of monetary policy on the output gap using the dynamic spatial Durbin model. Previous studies have emphasized static spatial approaches (Blasques et al. 2016; Huang et al. 2022a). Dynamic considerations, such as monetary policy, tend to change over time regarding the policies of the monetary authorities of the world's leading countries, and the transmission of monetary policy requires a time lag (Fasanya et al. 2021; Liu et al. 2019; Warjiyo and Juhro 2019). This method is essential because the territorial aspect affects the accuracy of the estimates through endogenous, exogenous, and error components (Anselin 2007; Elhorst et al. 2013). Furthermore, the dynamic spatial Durbin model (DSDM) approach in this study controls for the time-period effect to address the problem of the coefficient of the diffusion term being overestimated, as found in earlier literature (Abiad and Shoka 2004; Rios et al. 2017; X. Tang 2022; Anselin 2007; Elhorst et al. 2013; Wang et al. 2023; Arogundade et al. 2022).

Moreover, the exchange rate regime within a country can affect the fluctuations in the exchange rate of the domestic currency against hard currencies (Anh et al. 2018; Dimitriou et al. 2017; Iacoviello and Navarro 2019; Liu et al. 2019). Exchange rate fluctuations can further affect foreign capital flows and spillover velocities (Georgiadis 2016; Iacoviello and Navarro 2019). This study further analyses the effect of the exchange rate on the output gap, which has rarely been explored.

This study estimates the impact of the US interest rate spillover on the output gap of ASEAN+3 countries for the 2010–2020 period using the DSDM. Additionally, this study incorporates the exchange rate and COVID-19 pandemic shock into the model to empirically estimate the impact of these variables on the output gap by considering institutional variables as control variables.

The rest of the paper is structured as follows. The literature review is presented in the second section. The third section presents the methodology. The fourth section discusses the empirical results and discussion, and the last section provides conclusions and recommendations.

## 2. Literature Review

Governments worldwide are currently implementing policies to overcome the scarring effects of the pandemic and support the transformation of the global economy. Economic recovery strategies can be implemented through fiscal and monetary stimuli to increase national output (Baldwin and Mauro 2020; Hubbard et al. 2014; Iacoviello and Navarro 2019). The central bank can maintain its benchmark interest rate to reduce recessionary pressure through policy coordination and quantitative easing (Utama et al. 2022).

A country's central bank determines its interest rate as a reference for other banks in its financial system (Iacoviello and Navarro 2019; Ntshangase et al. 2023). Changes in the benchmark interest rate policies of leading countries worldwide are followed by changes in other countries' interest rate policies in the same direction (Georgiadis 2016; Iacoviello and Navarro 2019; Miranda-Agrippino and Rey 2020).

From a neoclassical perspective, the transmission mechanism of a central bank's monetary policy can occur through the interest rate channel (Hubbard et al. 2014; Warjiyo and Juhro 2019). An expansive interest rate monetary policy may influence the real sector by lowering capital costs, thereby increasing aggregate demand to revitalize the economy (Blanchard 2019; Sanfilippo-Azofra et al. 2017; Z. Tang 2022; Warjiyo and Juhro 2019). National production and various economic sectors gradually recovered over time. The output gap and employment opportunities will increase again (Hubbard et al. 2014; Tian et al. 2023). Furthermore, the impact of variable interest on the output gap is discussed.

### *2.1. The Impact of Interest Rate Spillover on the Output Gap*

The literature states that a central bank's interest rate plays a significant role in the development of the financial sector (Blasques et al. 2016; Iacoviello and Navarro 2019; X. Tang 2022). Global economic links exist between countries because they are already interconnected. Policy diffusion is the strongest among related countries (Elhorst et al. 2013). Miranda-Agrippino and Rey (2020) mention that the monetary policy of a leading country in a region affects the monetary policy of other countries in the same region. In this case, a spatial linkage exists between countries.

This spillover effect may occur because countries can implement discretionary rather than rule-based policies. The monetary spillover effect refers to the transmission of monetary policies from one country to another (Elhorst et al. 2014; Miranda-Agrippino and Rey 2020). This occurs when changes in monetary policies in one country cause changes in economic conditions, such as output levels, exchange rates, interest rates, and inflation, in another country (Iacoviello and Navarro 2019; Tian et al. 2023; Bräuning and Sheremirov 2019). Other countries follow the expansionary monetary policies implemented by leading countries to drive the real sector in the region. Based on this, Hypothesis 1 is proposed.

**Hypothesis 1.** *The impact of interest rate spillovers on the output gap is negative.*

### *2.2. The Impact of Exchange Rate on the Output Gap*

Foreign exchange rates fluctuate in an open economy experiencing a multidimensional crisis. The foreign exchange rate is the exchange rate of a domestic currency against another country's currency (Anh et al. 2018; Iacoviello and Navarro 2019). Most ASEAN+3

countries adhere to free-float exchange rate regimes. Fluctuations in the foreign exchange rate determine capital flows, inflation, and national output (Anh et al. 2018; Georgiadis 2016; Iacoviello and Navarro 2019). In a free-floating exchange rate system, the foreign exchange rate is determined by the demand and supply of foreign exchange (Iacoviello and Navarro 2019; Liu et al. 2019). However, the central bank controls the movement of the domestic currency (Hardi et al. 2015). In response to the Fed's interest rate, the monetary authorities of ASEAN+3 countries implemented an expansionary monetary policy to improve economic conditions due to the COVID-19 pandemic. This interest rate spillover effect results in the appreciation of the domestic currency against foreign currencies and an increase in the output gap (Iacoviello and Navarro 2019; Krugman et al. 2018; Ntshangase et al. 2023). Thus, Hypothesis 2 is proposed.

**Hypothesis 2.** *The impact of the exchange rate on the output gap is negative.*

### *2.3. The Impact of the COVID-19 Pandemic on the Output Gap*

The COVID-19 pandemic is an external shock that has caused uncertainty. The coronavirus has mutated repeatedly, altering its transmissibility, risk profile, and symptoms. Restrictive policies to control viral transmission by restricting the international movement of people, capital, and products have resulted in a decrease in aggregate demand, employment opportunities, and output gaps (Krista et al. 2020; Ing and Vadila 2022; Kazunobu and Hiroshi 2021; Qian and Jiang 2020; Vidya and Prabheesh 2020; Wuri et al. 2022). Based on this, Hypothesis 3 is proposed.

**Hypothesis 3.** *The impact of the COVID-19 pandemic on the output gap is negative.*

## 3. Methodology

### *3.1. Data*

This study uses panel data from ASEAN member countries, East Asian countries, and the US from 2010 to 2020. The ASEAN member states include Indonesia, Malaysia, the Philippines, Singapore, Thailand, Brunei, Vietnam, Laos, and Cambodia. The East Asian countries include China, Japan, and the Republic of Korea (hereafter Korea). ASEAN and The East Asian countries are referred to as ASEAN+3. In this study, the US was chosen as a reference country because the US central bank (the Fed) is the world's leading central bank whose policies have a spatial effect on ASEAN+3 countries. We use annual data on the central bank's output gap and interest rates. The interest rate in this study uses the real Central Bank interest rate. Real interest rates are inflation-adjusted interest rates, which are a crucial policy tool for central banks (Kiley 2020; Omay et al. 2017). This study also includes the exchange rate and shock of the COVID-19 pandemic as variables of interest. Additionally, this study considers institutional variables as control variables (Kaufmann et al. 2010; Zergawu et al. 2020). These data are presented in Table 1.

The data used in this study were obtained from International Financial Statistics (IFS), World Development Indicators (WDI), and Worldwide Governance Indicators (WGI) published by the World Bank.

**Table 1.** Variable Description.

| Variable | Definition | Measurement | Unit | Sources |
|---|---|---|---|---|
| y | Output gap | Percentage deviation of real Gross Domestic Product (GDP) from potential GDP (constant 2015). | US$ | WDI-World Bank |
| r | Interest rate | Real Central Bank policy rate. | % | IFS |
| er | Exchange rate | Domestic currency's representative exchange rate per U.S. dollar at market rates. | Rate | IFS |

**Table 1.** *Cont.*

| Variable | Definition | Measurement | Unit | Sources |
|---|---|---|---|---|
| COVID-19 | COVID-19 pandemic shocks | Gross export gap (the difference between the real and potential value of high technology exports). | US$ | WDI-World Bank |
| ins | Institutional index | The average of six institutional indices of the World Bank, including voice and accountability, political stability and absence of violence/terrorism, government effectiveness, regulatory quality, the rule of law, and control of corruption. | Index lies between −2.5 and 2.5 | WGI-World Bank |

Source: Compiled by the author.

### *3.2. Dynamic Spatial Panel Model Specifications*

The spatial econometric approach measures the relevance of the spatial spillover of a central bank's interest rate to the output gap. The monetary policy of the monetary authority of a leading country affects the performance of economies in other countries in the region (Ezcurra and Rios 2015; Georgiadis 2016; Iacoviello and Navarro 2019; Miranda-Agrippino and Rey 2020). This situation implies spatial dependence between countries. Therefore, this must be considered in econometric models (Anselin 2007; Elhorst et al. 2013; Miranda-Agrippino and Rey 2020; Li et al. 2023).

Spatial econometrics is a discipline of economics that studies spatial aspects, specifically the relationship between regions and variations in regional structures (Anselin 2007; Baltagi 2005; Elhorst et al. 2013; LeSage 2015; Arogundade et al. 2022). Following the first law of geography, everything is related to everything else, but near things are more connected than things that are far away (Anselin 2007; Miller 2004). Additionally, neighboring countries and countries located outside the region can be interrelated. Spatial dependence occurs because these countries are important trading partners (Arogundade et al. 2022; Miranda-Agrippino and Rey 2020; Bräuning and Sheremirov 2019).

Spatial dependency models are typically developed first by defining a spatial connectivity matrix (Anselin 2007; Li et al. 2023). The matrix depicts location dependencies. Hence, the size of the spatial weight significantly affects the estimation of the spatial dependence models. There are several ways to determine the spatial weight. The spatial weighting matrix is determined based on the proximity of geographical relationships (contiguity) or distance weights (Arogundade et al. 2022).

A spatial contingency weighting matrix is based on neighboring relationships. The weighting matrix using the inverse distance method was determined based on the actual distance between locations (Elhorst et al. 2014; Li et al. 2023). The inverse matrix gives larger weight values for shorter distances and smaller ones for longer distances. Calculating the distance between locations requires information on the latitude and longitude coordinates of the center point of the observed location (Arogundade et al. 2022).

### *3.3. Dynamic Spatial Durbin Model (DSDM)*

The DSDM is one of the spatial models that can estimate the relationship of dependent variables between regions (lag spatial dependent) and the relationship of dependent variables in one region with independent variables in other regions (Elhorst et al. 2013; Goschin et al. 2021; Rios et al. 2017). This method is essential because the territorial aspect affects the accuracy of the estimates through endogenous, exogenous, and error components (Anselin 2007; Elhorst et al. 2013; Huang et al. 2022b). Furthermore, this dynamic spatial approach was used to avoid the challenge of estimating biased and inefficient coefficients (Z. Tang

2022). The relationships between the dependent variables of the regions can be written as follows:

$$cov\left[y_i, y_j\right] = E\left[y_i y_j\right] - E\left[y_i\right].E\left[y_j\right] \neq 0 \text{ untuk } i \neq j \quad (1)$$

where $i$ and $j$ indicate the observation of the location and are the values of the random variables at that location. The DSDM for estimating the spatial spillover of interest rate policy on the output gap is as follows (Anselin 2007; Elhorst et al. 2013; Goschin et al. 2021; Rios et al. 2017):

$$Y_{it} = \tau Y_{it-1} + \rho \sum_{j=1}^{J} W_{ijt} Y_{jt} + \eta \sum_{j=1}^{J} W_{ijt} Y_{jt-1} + \sum_{k=1}^{K} X_{itk}\, \beta_k + \sum_{k=1}^{K} \sum_{j=1}^{J} W_{ijt} X_{jtk} \theta_k + \varepsilon \quad (2)$$

where $t = 1, \ldots, T$ is the year index, i = 1, …, $N$ is the index referring to the country being analysed, $k = 1, \ldots, K$ is the index referring to explanatory variables, $Y_{it}$ is the output gap of country $i$ during period $t$, $Y_{jt}$ is the output gap of country $j$ during period $t$, and $W_{ijt}$ is an $n \times n$ spatial weighting matrix. $X_{it}$ is the vector of the independent variable in country $i$ during period $t$. $X_{jt}$ the vector of the independent variable in country $j$ during period $t$. $\varepsilon$ is the error term. $\tau$, $\rho$, and $\eta$ show the parameter response of the dependent variable's lag in time, space, and in time and space (Elhorst et al. 2013). $Y_{it-1}$ is the lag in the dependent variable over time. $W_{ijt}Y_{jt}$ is the lag of the dependent variable in space and $W_{ijt}Y_{jt-1}$ is the lag of the dependent variable in time and space.

The equation includes variables that affect the output gap, namely the central bank's interest rate (r) and exchange rate (er). The model also includes control variables, particularly institutional variables (ins). Moreover, this study examines the impact of the COVID-19 shock on the output gap.

The DSDM in Equation (2) reveals spatial dependencies in the dependent and independent variables. This model was based on the influence of spatial dependencies. Therefore, testing spatial dependencies is required before modelling. The cross-sectional dependency (CD) Pesaran method can be used to measure spatial autocorrelation estimators for spatial data (Elhorst et al. 2014; Pesaran 2021). The CD Pesaran approach is more commonly employed to calculate global spatial autocorrelation. This technique can detect the beginning of the spatial randomization (Pesaran 2021). The DSDM interpretation requires the calculation of direct, indirect, and total effects (Elhorst et al. 2013; LeSage 2015; Rios et al. 2017; Li et al. 2023; Huang et al. 2022a). Direct effects capture the effects on the output gap in country i caused by changes in the exogenous variables in country i. Indirect effects can be interpreted as the effects of changes in the exogenous variables in all other countries j ≠ i on the output gap in country i. The total effect is the sum of the direct and indirect impacts. The DSDM generates accurate estimations of direct effects and robust results (Huang et al. 2022b; Z. Tang 2022). Moreover, this study employed a maximum likelihood estimation approach to create consistent parameter estimates.

Employing a dynamic spatial spillover model can accommodate dynamic interest rate monetary policy and anticipate time lags in implementing monetary policy transmission through interest rate channels (Elhorst 2021; Warjiyo and Juhro 2019). Additionally, dynamic spatial models allow us to empirically investigate both short- and long-term effects (Goschin et al. 2021; Rios et al. 2017). The impact of a variable is measured both in the reference region (direct effect) and in neighboring regions (indirect effect) to improve the understanding of economic phenomena. The DSDM provides accurate estimates of the direct effects, and this result is robust.

Furthermore, the determination of the spatial weighting matrix in this study used an inverse distance matrix with cutoff and normalised rows (Arogundade et al. 2022). The inverse distance is made up of weights that are inversely proportional to the unit distances. This is specified as:

$$W_{ij} = \begin{cases} 0, & i = j \\ 1/d_{ij}^2, & i \neq j \end{cases} \quad (3)$$

where $W_{ij}$ is the inverse distance matrix and $d_{ij}$ is the distance of spatial unit $i$ to spatial unit $j$. The DSDM addresses the problems of serial correlation, heteroscedasticity, and endogeneity (Baltagi 2005; Elhorst et al. 2014; Z. Tang 2022).

The shock of the COVID-19 pandemic in this study was measured based on the gross export gap, which is the difference between actual and potential exports (Hubbard et al. 2014; Wuri et al. 2022). The rise and fall of the gross export gap directly impacts economic fluctuations. Identifying this gap can help a country achieve its best performance (González and Kowalski 2017). A recession occurs when the potential value exceeds the actual value and vice versa. As potential gross exports are difficult to observe in the real world, they are proxied by expected values. The study used Hodrick–Prescott filters to determine the potential gross export value (Anh et al. 2018; Hubbard et al. 2014).

### *3.4. Robustness Checks*

The robustness test is performed to evaluate the consistency of the relationship between variables of interest. The study used short panel data to determine whether the estimated results were consistent with the main results (Kaufmann et al. 2010).

## 4. Empirical Results and Discussion

This section discusses the estimation results from the interest rate spillover in the output gap model, where the interest rate, exchange rate, and COVID-19 pandemic are our variables of interest, with institutional quality as a control variable. Table 2 presents the descriptive statistics.

**Table 2.** Descriptive Statistics.

| Group | Statistics | y | r | er | Covid19 | ins |
|---|---|---|---|---|---|---|
| ASEAN | Mean | $1.15 \times 10^{-6}$ | 0.2762 | 5110.77 | 0.0012 | −0.0338 |
| | SD | 0.0234 | 1.8870 | 7224.41 | 0.4129 | 0.7297 |
| | Maximum | 0.0553 | 5.8688 | 23,208.4 | 2.1011 | 1.6394 |
| | Minimum | −0.0858 | −5.0678 | 1.2496 | −1.4167 | −1.0013 |
| East Asia | Mean | 0.00003 | −0.1363 | 412.088 | $4.52 \times 10^{-6}$ | 0.5654 |
| | SD | 0.0122 | 0.9505 | 516.056 | 0.0695 | 0.7585 |
| | Maximum | 0.0190 | 1.1987 | 1180.27 | 0.1869 | 1.3760 |
| | Minimum | −0.0436 | −3.3039 | 6.1434 | −0.1213 | −0.5758 |
| United States | Mean | −0.00001 | −1.0752 | 1.0000 | −0.0001 | 1.2162 |
| | SD | 0.0118 | 0.9433 | 0.0000 | 0.0493 | 0.0893 |
| | Maximum | 0.0181 | 0.2564 | 1.0000 | 0.0772 | 1.2771 |
| | Minimum | −0.0278 | −3.0318 | 1.0000 | −0.0692 | 0.9746 |
| Total | Mean | $6.24 \times 10^{-6}$ | 0.0770 | 3633.40 | 0.0008 | 0.2007 |
| | SD | 0.0205 | 1.6826 | 6405.88 | 0.3449 | 0.8043 |
| | Maximum | 0.0553 | 5.8688 | 23,208.4 | 2.1011 | 1.6394 |
| | Minimum | −0.0858 | −5.0678 | 1.0000 | −1.4167 | −1.0013 |

Notes: y = output gap; r = central bank interest rate; er = exchange rate; Covid19 = COVID-19 shocks; ins = institutional variables. Source: Author's calculation.

### *4.1. Descriptive Statistics*

Table 2 presents the descriptive statistics of the study variables by country. The maximum value of the ASEAN output gap was 0.06, whereas the minimum value was −0.09. The Philippines had the highest output gap among ASEAN countries during the observation period in 2019 and the lowest in 2020. A standard deviation of 0.02 implies minimal dispersion from the sample means.

The average central bank interest rate in ASEAN countries was 0.28%. Singapore had the lowest central bank rate in 2011 (−5.07%), whereas Vietnam had the highest (5.87%).

A standard deviation of 1.89 represents the sample's average minimal dispersion. Brunei had the lowest exchange rate in 2012 (1.25), while Vietnam had the highest, at 23,208.4 in 2020. The standard deviation of 7224.41 from the sample mean of 5110.77 indicates a large dispersion between countries. The sample average for COVID-19 ASEAN countries was 0.0012, whereas the average for the institutional variables was −0.03. Lao PDR had the lowest institutional variable in 2010 at −1.00, whereas Singapore had the highest value at 1.64 in 2020. A standard deviation of 0.73 indicates a large dispersion from the sample mean between countries.

Furthermore, the average output gap in East Asian countries is 0.00003, whereas the average central bank interest rate is −0.14%. The South Korean won to US dollar exchange rate was the highest in East Asia at 1180.27, whereas the Chinese yuan renminbi to US dollar exchange rate was the lowest at 6.14. East Asian countries had an average value of 0.57 for institutional variables. Contrastingly, the US has an average central bank interest rate of −1.08%. The US exchange rate was used as the reference exchange rate. Regarding institutional factors, the US has the highest average value at 1.22.

### *4.2. Panel Unit Root Test*

We perform a unit root test for the variables of interest using the Levin, Lin, and Chu (LLC) tests. The LLC test assumes a unit root process for each individual (Elhorst et al. 2014; Wuri et al. 2023). This is widely used in panel data unit root testing. Consequently, we utilised unit root tests for ASEAN countries, East Asian countries, and the US.

As presented in Table 3, the test value for LLC ranges from −2.69 to −15.68. All variables are stationary from 2010 to 2020 because the corresponding *p*-values for the tests were <0.05, implying that the null hypothesis (H0; all panels containing a unit root) is rejected.

**Table 3.** Levin, Lin, and Chu (LLC) panel unit root test.

| Variables | T Statistics | *p*-Value |
|---|---|---|
| y | −2.6919 | 0.0036 |
| r | −2.2174 | 0.0133 |
| er | −3.5217 | 0.0002 |
| Covid19 | −3.4581 | 0.0003 |
| ins | −15.6805 | 0.0000 |

Notes: LLC = Levin–Lin–Chu; y = output gap; r = central bank interest rate. er = exchange rate; Covid19 = COVID-19 shocks; ins = institutional variable.

### *4.3. Output Gap and Central Bank Interest Rate in the US and ASEAN+3*

Figures 1 and 2 illustrate a map of the spatial grouping of central banks and ASEAN+3 interest rates and output gap rates for 2020. Indonesia and other ASEAN countries have high central bank interest rates, which are classified in the group of 0.78% to 2.89%. East Asian countries, namely China, Japan, and Korea, are classified into the middle group, and the United States is ranked in the lowest real interest rate group (Figure 1).

Compared to the previous year, average central bank interest rates in ASEAN+3 have fallen in response to the Fed's policy of gradually lowering interest rates due to the COVID-19 pandemic. This has increased output gaps in some ASEAN+3 countries.

Figure 2 shows that the US and the East Asian countries have strong trade relations. These countries have large output gaps compared to others, classified in the highest group (−0.028 to 0.033 billion USD) and the medium group (−0.044 to −0.028 billion USD). The value of the output gap is still negative in connection with the decline in economic conditions due to the COVID-19 pandemic. This condition has improved with monetary expansion.

In contrast, Indonesia, Malaysia, the Philippines, Singapore, and Thailand, countries with close trade relations and geographical proximity, are classified in the group of countries with output gap rates in the middle group (−0.044 to −0.028 billion USD) and lowest group (−0.086 to −0.044 billion USD). The figures show the spillover effect of US monetary

authority policy on the output gap of countries in the region (Georgiadis 2016; Ntshangase et al. 2023; Miranda-Agrippino and Rey 2020).

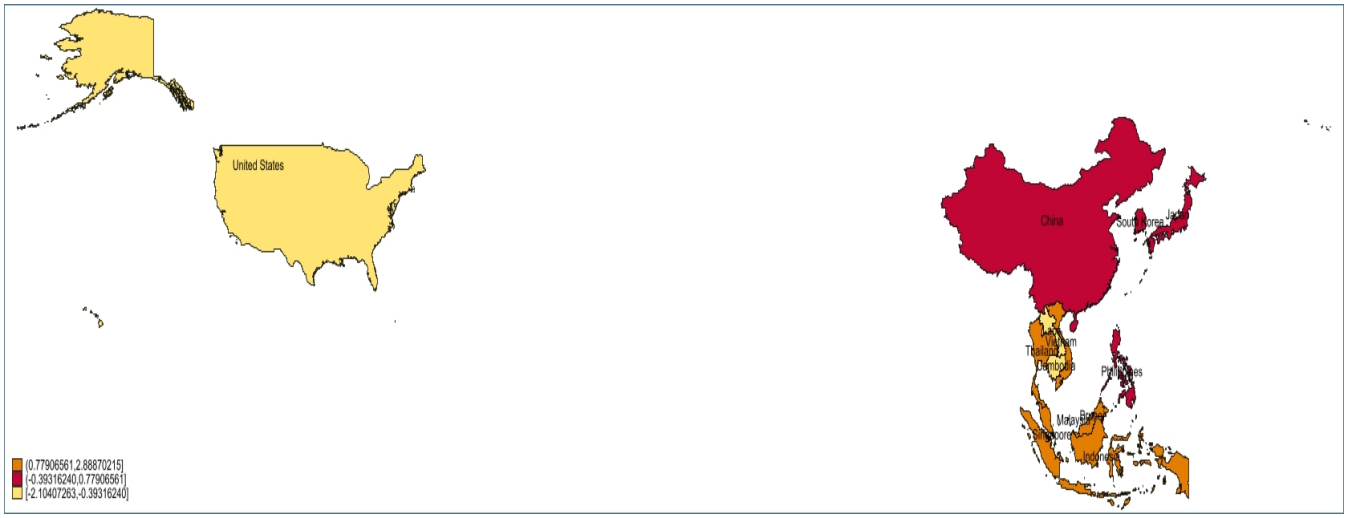


**Figure 1.** Interest rate in the United States and ASEAN+3 in 2020.

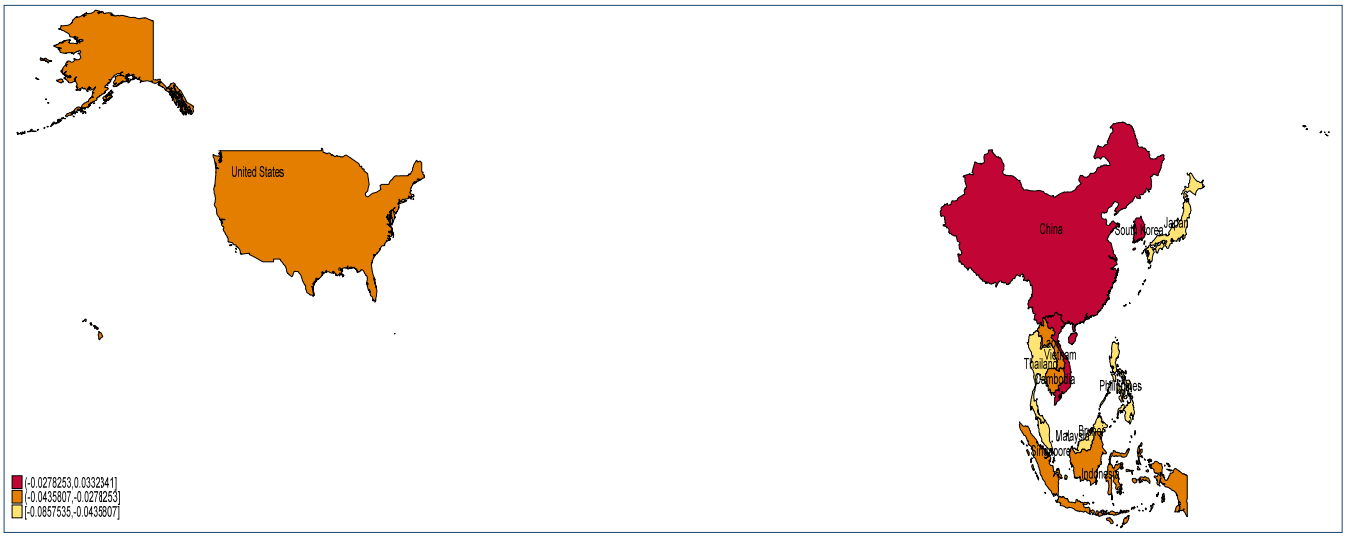


**Figure 2.** Output gap in the United States and ASEAN+3 in 2020. Source: Drawn by authors.

### *4.4. DSDM Estimation Result*

The results of the spatial dependence test using the CD Pesaran test showed a value of 16.149 (0.000), confirming spatial dependence between the observed variables. Table 4 presents the results of the DSDM estimation using an inverse-distance matrix with a cutoff of 15,000 km, considering the distance between the ASEAN+3 countries and the US. Column 1 shows the coefficient of the estimated spillover effect of monetary policy on the output gap (see Model 1). Model 2 included the impact of the COVID-19 pandemic on the output gap. The DSDM also includes time-invariant control variables, namely, institutional variables (Aibai et al. 2019; Kaufmann et al. 2010; Zergawu et al. 2020). Model 3 shows the estimation results.

**Table 4.** Result of dynamic spatial Durbin model estimation, 2010–2020.

| Variables | Coefficient | | |
|---|---|---|---|
| | **(1)** | **(2)** | **(3)** |
| y(−1) | 19.107 *** | 12.913 *** | 11.271 *** |
| | (0.000) | (0.000) | (0.000) |
| Wy (−1) | 75.867 *** | 80.792 *** | 87.594 *** |
| | (0.000) | (0.000) | (0.000) |
| r | −0.105 *** | −0.122 *** | −0.035 *** |
| | (0.000) | (0.000) | (0.000) |
| er | −0.001 *** | −0.001 *** | −0.00006 ** |
| | (0.000) | (0.000) | (0.026) |
| Covid19 | | −0.584 *** | −0.071 *** |
| | | (0.000) | (0.004) |
| ins | | | 0.627 *** |
| | | | (0.000) |
| W. r | −0.424 *** | −0.539 *** | −0.203 *** |
| | (0.000) | (0.000) | (0.000) |
| W. er | −0.009 *** | −0.011 *** | −0.002 *** |
| | (0.000) | (0.000) | (0.000) |
| W. Covid19 | | −1.794 *** | −0.474 *** |
| | | (0.000) | (0.000) |
| W. ins | | | 2.557 *** |
| | | | (0.000) |
| $\rho$ | 2.889 *** | 1.427 *** | 0.670 *** |
| | (0.000) | (0.000) | (0.000) |
| No. of observations | 65 | 52 | 26 |
| No. of countries | 13 | 13 | 13 |
| Sigma2_e | 0.0006 *** | 0.0005 *** | 0.00002 *** |
| | (0.000) | (0.000) | (0.000) |

Notes: y = output gap; r = central bank interest rate; er = exchange rate; Covid19 = COVID−19 shocks; ins = institutional variable; robust standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$. Source: Author's calculation using Stata 17.

The estimates of the coefficient of the lag of the dependent variable in time (y(−1)) showed positive and significant results across all models. This implies that the output gap in the past period positively affects that of the current period. A development of the output gap is observed in Indonesia and other ASEAN+3 countries. The spatial parameter lag ($\rho$) was positive and significant at 2.889 for Model 1. For Model 2, it was 1.427 and for Model 3, it was 0.670. This shows that the development of an output gap in one country correlates with the development of an output gap in the surrounding countries (Georgiadis 2016; Ntshangase et al. 2023; Miranda-Agrippino and Rey 2020). In this case, there is competitiveness between countries, where the economic conditions in a country will be better if the economic conditions of neighboring countries in one region perform well.

Furthermore, the results show that the central bank's interest rate negatively and significantly affects the output gap in all the models. The negative effects were persistent in the short term, both directly and indirectly (see Table 5). The fact that the W.r. coefficient is negative and significant across all models suggests a negative diffusion spillover effect of the Fed's monetary policies on the output gap of regional countries by considering the quality of institutions as a control variable. The results of this study support Hypothesis 1 and those of previous studies (Bhattarai et al. 2020; Georgiadis 2016; Iacoviello and Navarro 2019; Tian et al. 2023). These negative spillover effects are driven by indirect and significant total effects in the short-term (see Table 5).

The expansionary central bank interest rate policy implemented by the monetary authorities of the world's leading countries to overcome the COVID-19 pandemic will increase the domestic output gap owing to the response of domestic central banks to the policy (Georgiadis 2016; Iacoviello and Navarro 2019). These results support the empirical relevance of negative spatial spillover in this context. This situation demands serious attention from the government

and monetary authorities due to the deterioration of economic conditions. These results are consistent with a highly interdependent economic environment in which changes across countries interacting within the system are more relevant than changes in a single country. To achieve sustainable economic development, it is necessary to maintain an expansionary monetary policy because the total spillover effect is significant in the short and long terms, as theoretically stated (Elhorst et al. 2014; Rios et al. 2017).

**Table 5.** Result of spatial effect decomposition.

| Effects | | Variables | Coefficient | | |
|---|---|---|---|---|---|
| | | | (4) | (5) | (6) |
| Short-run | Direct effects | r | −0.052 *** | −0.082 *** | −0.025 *** |
| | | | (0.000) | (0.000) | (0.000) |
| | | er | 0.002 *** | −0.0004 *** | 0.0003 |
| | | | (0.002) | (0.000) | (0.342) |
| | | Covid19 | | −0.477 *** | −0.048 * |
| | | | | (0.000) | (0.088) |
| | | ins | | | 0.510 *** |
| | | | | | (0.000) |
| | Indirect effects | r | −0.084 *** | −0.191 *** | −0.119 *** |
| | | | (0.000) | (0.000) | (0.000) |
| | | er | −0.004 *** | −0.005 *** | −0.001 *** |
| | | | (0.000) | (0.000) | (0.000) |
| | | Covid19 | | −0.506 *** | −0.284 *** |
| | | | | (0.000) | (0.000) |
| | | ins | | | 1.440 *** |
| | | | | | (0.000) |
| | Total effects | r | −0.136 *** | −0.273 *** | −0.144 *** |
| | | | (0.000) | (0.000) | (0.000) |
| | | er | −0.003 *** | −0.005 *** | −0.001 *** |
| | | | (0.000) | (0.000) | (0.000) |
| | | Covid19 | | −0.983 *** | −0.332 *** |
| | | | | (0.000) | (0.000) |
| | | ins | | | 1.950 *** |
| | | | | | (0.000) |
| Long-run | Direct effects | r | 0.006 *** | 0.005 *** | 0.119 |
| | | | (0.000) | (0.000) | (0.816) |
| | | er | 0.0004 *** | 0.0001 *** | 0.0007 |
| | | | (0.000) | (0.000) | (0.875) |
| | | Covid19 | | 0.009 *** | 0.268 |
| | | | | (0.000) | (0.824) |
| | | ins | | | −1.707 |
| | | | | | (0.771) |
| | Indirect effects | r | −0.0001 | 0.002 *** | 1.145 |
| | | | (0.840) | (0.000) | (0.852) |
| | | er | −0.0003 *** | −0.00001 *** | 0.009 |
| | | | (0.000) | (0.000) | (0.868) |
| | | Covid19 | | 0.017 *** | 2.665 |
| | | | | (0.000) | (0.855) |
| | | ins | | | −14.522 |
| | | | | | (0.837) |
| | Total effects | r | 0.006 *** | 0.007 *** | 1.264 |
| | | | (0.000) | (0.000) | (0.850) |
| | | er | 0.0001 *** | 0.0001 *** | 0.009 |
| | | | (0.000) | (0.000) | (0.868) |
| | | Covid19 | | 0.026 *** | 2.933 |
| | | | | (0.000) | (0.852) |
| | | ins | | | −16.229 |
| | | | | | (0.832) |

Notes: y = output gap; r = central bank interest rate; er = exchange rate; Covid19 = COVID-19 shocks; ins = institutional variable; robust standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$. Source: Author's calculation using Stata 17.

Table 4 shows that the effect of foreign exchange rates on the output gap is negative and significant in all models. These results support Hypothesis 2 and correspond with the study by Iacoviello and Navarro (2019). The decline in the output gap further affects current account imbalances (Cota et al. 2017). Economic conditions affected by a multidimensional

crisis also affect fluctuations in foreign exchange rates (Liu et al. 2019; Georgiadis 2016; Ntshangase et al. 2023). High exchange rate fluctuations cause economic uncertainty and may disrupt sustainable economic growth (Ntshangase et al. 2023). Proper monetary policy and better regulatory quality can encourage increased national output (Francois and Manchin 2013; Rios et al. 2017). The Fed's monetary policy to overcome the COVID-19 pandemic has resulted in interest rate spillover effects to countries in other regions, especially ASEAN+3. The value of the domestic currency of regional countries depreciated, resulting in a decrease in the output gap, which was lower than its potential. This can occur because the effect's value is higher than its volume (Iacoviello and Navarro 2019; Krugman et al. 2018) This effect is more pronounced in the short term.

The DSDM estimates show that the COVID-19 pandemic has caused declining economic conditions and significantly reduced the output gap. These results support Hypothesis 3. Social distancing and lockdown policies limit economic activity and affect the output gaps. Production and trade activities have slowed down owing to the COVID-19 pandemic. Further consequences include reducing the national and global output gaps (Baldwin and Mauro 2020; Meier and Pinto 2020; Qian and Jiang 2020; Alfano and Ercolano 2021; Ing and Vadila 2022; Wuri et al. 2022). The negative effects of the economic crisis will continue to be experienced in the long term. The economic recovery process runs gradually and differs among countries. Countries with stronger and more stable economic conditions tend to experience faster economic recovery than those with weak economic conditions owing to high vaccination rates and herd immunity.

Quality institutions can encourage national economic growth (Aibai et al. 2019; Alfano and Ercolano 2021; Francois and Manchin 2013; Zergawu et al. 2020) This is indicated by a positive and significant institutional coefficient of 0.627 (Model 3). In Model 3, it can be seen that the direct and indirect effects of positive and significant institutional quality are felt more in the short term.

Information on the direct, indirect, and total effects of DSDM is presented in Table 5. The indirect effects differed from those of the W. r. coefficient. This difference is due to feedback effects from impacts that pass through other countries and return to that country (Rios et al. 2017). In Table 5, most of the direct, indirect, and total effect coefficients in the short term pass the significance test, which shows the negative effects of the US interest rate spillover that can affect the output gap of ASEAN+3 countries by considering institutional variables as control variables (Iacoviello and Navarro 2019; Tian et al. 2023).

Moreover, the pandemic has had both direct and indirect negative effects in the short term. Social restriction policies imposed on various countries disrupt supply chains and decrease trade flows between countries, further reducing national output (Baldwin and Mauro 2020; Meier and Pinto 2020; Qian and Jiang 2020; Alfano and Ercolano 2021; Fasanya et al. 2021; Ing and Vadila 2022; Wuri et al. 2023). In order to recover economic conditions, precise monetary policy is needed due to its spillover effect (Georgiadis 2016; Ntshangase et al. 2023; Miranda-Agrippino and Rey 2020). Expansionary monetary policy and controlled exchange rates are needed to increase the output gap and capital inflow (Aziz et al. 2022; Chudik et al. 2021; Chong et al. 2021; Feldkircher et al. 2021; Nguyen et al. 2022).

### *4.5. Robustness Test Results*

Table 6 shows that the estimated robustness test results with short panels are consistent with the main results (Kaufmann et al. 2010). There is a negative spillover effect of the US central bank's interest rate monetary policy on the output gap of countries in other regions, namely ASEAN+3, indicated by negative and significant coefficient values of −0.157, −0.539, and −0.130 in Model 7, Model 8, and Model 9, respectively. The monetary policy of the world's leading central bank, the US, will be responded to by the central banks of countries in the region (Miranda-Agrippino and Rey 2020; Tian et al. 2023).

**Table 6.** The empirical result of robustness test, 2016–2020.

| Variables | Coefficient | | |
|---|---|---|---|
| | **(7)** | **(8)** | **(9)** |
| y(−1) | 3.359 *** | 9.474 *** | 2.622 *** |
| | (0.000) | (0.000) | (0.000) |
| Wy (−1) | 16.493 *** | 60.639 *** | −1.276 |
| | (0.000) | (0.000) | (0.727) |
| r | −0.032 *** | −0.036 *** | −0.042 *** |
| | (0.000) | (0.000) | (0.000) |
| er | −0.0002 *** | −0.001 *** | −0.0003 *** |
| | (0.000) | (0.000) | (0.000) |
| Covid19 | | −0.114 *** | −0.118 *** |
| | | (0.000) | (0.003) |
| ins | | | 0.457 *** |
| | | | (0.000) |
| W. r | −0.157 *** | −0.539 *** | −0.130 *** |
| | (0.000) | (0.000) | (0.000) |
| W. er | −0.001 *** | −0.008 *** | −0.002 *** |
| | (0.000) | (0.000) | (0.000) |
| W. Covid19 | | −1.502 *** | −0.375 *** |
| | | (0.000) | (0.000) |
| W. ins | | | 3.674 *** |
| | | | (0.000) |
| $\rho$ | 2.062 *** | 3.754*** | 2.700 *** |
| | (0.000) | (0.000) | (0.000) |
| No. of observations | 26 | 26 | 26 |
| No. of countries | 13 | 13 | 13 |
| Sigma2_e | 0.00009 *** | 0.00003 *** | 0.00003 *** |
| | (0.000) | (0.004) | (0.000) |

Notes: y = output gap; r = central bank interest rate; er = exchange rate; Covid19 = COVID-19 shocks; ins = institutional variable; robust standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, and *$p < 0.1$. Source: Author's calculation using Stata 17.

As noted in the robustness test (see Table 6), the linkage between foreign exchange rates and the output gap is negative and significant. Similarly, the COVID-19 pandemic has decreased the national output gap.

Table 7 shows that the negative spillover effect of the central bank's interest rate on the output gap is vital in the short term, with both direct and indirect effects, according to the main results. Monetary authorities can issue regulations to restore economic conditions and gradually create sustainable economic development by implementing an expansionary monetary policy (Blanchard 2019; Zergawu et al. 2020).

**Table 7.** Robustness test of spatial effect decomposition, 2016–2020.

| Effects | | Variables | Coefficient | | |
|---|---|---|---|---|---|
| | | | **(10)** | **(11)** | **(12)** |
| Short-run | Direct effects | r | −0.017 ** | −0.033 | −0.040 |
| | | | (0.029) | (0.743) | (0.215) |
| | | er | 0.00004 | −0.0002 | 0.00001 |
| | | | (0.315) | (0.989) | (0.997) |
| | | Covid19 | | 0.116 | −0.100 |
| | | | | (0.980) | (0.673) |
| | | ins | | | −0.189 |
| | | | | | (0.969) |
| | Indirect effects | r | −0.046 *** | −0.007 | −0.006 |
| | | | (0.000) | (0.942) | (0.852) |
| | | er | −0.0005 *** | −0.002 | −0.0007 |
| | | | (0.000) | (0.919) | (0.805) |
| | | Covid19 | | −0.460 | −0.033 |
| | | | | (0.920) | (0.889) |
| | | ins | | | 1.314 |
| | | | | | (0.789) |

**Table 7.** *Cont.*

| Effects | | Variables | Coefficient | | |
|---|---|---|---|---|---|
| | | | **(10)** | **(11)** | **(12)** |
| | Total effects | r | −0.063 *** | −0.041 *** | −0.046 *** |
| | | | (0.000) | (0.000) | (0.000) |
| | | er | −0.0005 *** | −0.002 *** | −0.0007 *** |
| | | | (0.000) | (0.000) | (0.000) |
| | | Covid19 | | −0.344 *** | −0.132 *** |
| | | | | (0.000) | (0.000) |
| | | ins | | | 1.125 *** |
| | | | | | (0.000) |
| Long-run | Direct effects | r | −0.055 | 0.003 *** | 0.006 |
| | | | (0.979) | (0.000) | (0.858) |
| | | er | −0.0004 | 0.0001 *** | −0.00007 |
| | | | (0.975) | (0.000) | (0.895) |
| | | Covid19 | | 0.027 *** | 0.020 |
| | | | | (0.001) | (0.834) |
| | | ins | | | 0.190 |
| | | | | | (0.857) |
| | Indirect effects | r | −0.076 | 0.0002 | −0.224 |
| | | | (0.970) | (0.762) | (0.580) |
| | | er | −0.0007 | $-3.61 \times 10^{-6}$ | −0.003 |
| | | | (0.958) | (0.672) | (0.602) |
| | | Covid19 | | −0.003 | −2.610 |
| | | | | (0.700) | (0.548) |
| | | ins | | | 5.339 |
| | | | | | (0.667) |
| | Total effects | r | −0.132 *** | 0.003 *** | −1.218 |
| | | | (0.000) | (0.000) | (0.621) |
| | | er | −0.001 *** | 0.0001 *** | −0.003 |
| | | | (0.000) | (0.000) | (0.624) |
| | | Covid19 | | 0.025 *** | −0.590 |
| | | | | (0.000) | (0.594) |
| | | ins | | | 5.530 |
| | | | | | (0.681) |

Notes: y = output gap; r = central bank interest rate; er = exchange rate; Covid19 = COVID-19 shocks; ins = institutional variable; robust standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$. Source: Author's calculation using Stata 17.

## 5. Conclusions and Recommendations

Countries have recently become increasingly integrated. The policies of one country affect those of the other countries in a region. This study analyses the impact of the US interest rate spillover on the output gap of ASEAN+3 countries for the 2010–2020 period, considering the quality of institutions as a control variable. This study also examines the effect of exchange rates on the output gap. The shock of the COVID-19 pandemic was also considered in the model to empirically estimate its impact of the COVID-19 pandemic on the output gap. The DSDM, which considers spatial dependence between countries and generates consistent parameters, was used in this study.

The results show a negative and significant total spillover effect of the US central bank's interest rate monetary policy on the output gap of ASEAN+3 countries, considering institutional quality as a control variable. Studies have also shown that the past output gap positively affects the current output gap. Additionally, one country's output gap correlates with the output gap of the surrounding countries. Furthermore, the appreciation of the domestic currency increases the output gap.

The results revealed that the COVID-19 pandemic shock significantly and negatively impacted the global output gap. This effect is caused by the total negative effects in the short term, either directly or indirectly. According to the DSDM, economic circumstances can be enhanced if the monetary authority determines the interest rate monetary policy expansion. Negative and significant spatial spillovers indicate that each country's government must implement appropriate policies to overcome economic challenges.

ASEAN+3 countries may implement specific policy initiatives to mitigate the effects of the Fed's interest rate policy. Expansionary monetary policy, exchange rate stability,

and high-quality institutions are required to sustain economic stability and reduce the gap between actual and potential output. Furthermore, regional collaboration is needed to respond to the Fed's interest rate policy spillover effects. Future research should expand the analysis of spillover impacts of economic shocks to realize the broader impact of monetary policy spillovers on real economic variables.

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