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Dynamics of spatial monetary policy to achieve sustainable financial developments

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Abstract: The monetary authority's policy accuracy is needed to create stability in the global financial sector because countries are currently integrated into the world. The monetary policies of the world's leading countries influence those of other countries. This study aims to analyze the dynamic spatial effects of monetary policy on financial development between ASEAN+3 countries for the period 2010–2020 and examine whether there is sustainable financial development by considering regulatory quality as a control variable. The study also analyzes the impact of the COVID-19 pandemic on financial development. This study uses a dynamic spatial analysis model to capture spatial interactions, short-term and long-term effects, and obtain consistent parameters, using spatial weights based on distance. The results of the study show that monetary policy has a dynamic spatial spillover effect on financial development, both short-term and long-term. Monetary policy with contractionary lending rates can weaken financial development, and conversely, expansionary policies can encourage financial development so that sustainable financial development can be achieved. Empirical results also show that the COVID-19 pandemic weakened the global financial sector. These findings are robust to alternative model specifications.

Keywords: *COVID-19 pandemic, Dynamic spatial model, Financial development, Monetary policy, Regulatory quality.*

1. Introduction

The recent economic shocks have caused uncertainty and weakened the financial system both nationally and globally. The COVID-19 pandemic has also resulted in negative growth in global economic output [1]. Social restrictions or lockdowns in some countries have reduced financial and trade activities due to disruptions in global supply chains [2-4]. Investors and companies have difficulty fulfilling credit obligations, so the risk of bad loans increases, and the performance of the banking sector decreases [5]. An appropriate mix of government policies is needed to restore economic conditions [6].

The study of monetary policy is essential because the correctness of monetary policy can impact the financial sector, both nationally and internationally [7]. Contractionary monetary policy can weaken the financial sector, so the role of the Indonesia Deposit Insurance Corporation (IDIC) is needed to maintain public confidence in the banking sector [8]. The monetary authority can transmit monetary policy on interest rates, among others, through bank lending channels [9, 10]. This approach explains how the monetary policy transmission mechanism works through the behavior of banks in credit offerings to address the asymmetry of debtor business feasibility information. This policy avoids the risk of bad loans, impacting relative prices, aggregate demand, and inflation [11].

Inflationary economic conditions will be responded to by raising interest rates as a function of the central bank's reaction [12, 13]. On the contrary, the government's efforts to maintain relatively low interest rates can strengthen the financial sector and achieve financial sustainability. The change in the central bank's benchmark interest rate will be followed by a change in the lending rate in the same

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direction. Based on the literature, the correlation between lending rates and financial developments is negative [10, 14].

Financial development is defined as an index that measures the development of financial institutions and financial markets in terms of depth, access, and efficiency [15]. This measurement uses a comprehensive, broad, multidimensional approach to financial development, complementing previous research that remains partial [16, 17]. This approach follows a matrix of financial system characteristics developed by Čihák et al. [16]. This measurement is more accurate because it can describe the overall condition of the financial sector concerning changes in monetary policy. It is also crucial to see if sustainable financial development exists, considering that the financial sector is the foundation of economic development [5]. Sustainable financial development is the ability of institutions to provide financial services in terms of depth, access, and efficiency on an ongoing basis [15]. Previous studies on this subject have not been many, so this study addresses this.

Furthermore, financial development is not only influenced by the monetary policy of the country concerned but also by the monetary policy implemented by the monetary authority of the world's leading country. In this case, there is spatial dependence on policies between countries [18]. The benchmark interest rate policies of the world's leading central banks, such as the US Central Bank (the Fed), and the central banks of China, Japan, and Korea, affect the global economy. Given the scarcity of studies on the model of dynamic spatial dependence on monetary policy, this study complements the literature by analyzing the dependence of monetary policy on financial developments using the Dynamic Spatial Durbin model [19-21]. Dynamic considerations are important because monetary policy tends to change over time in response to the policies of the monetary authorities of the world's leading countries, and the transmission of monetary policy requires a time lag [11]. The Dynamic Spatial Durbin model approach in this study controls the time-period effect to overcome the coefficient problem of the diffusion term overestimated, as found in previous literature.

The concept of financial development measures financial institutions and financial markets in terms of depth (market size and liquidity), access (the ability of individuals and companies to access financial services), and efficiency (the ability of institutions to provide financial services at low costs and sustainable income, and the level of capital market activity) [15]. Financial institutions include banks, insurance companies, mutual funds, and pension funds. Meanwhile, the financial market consists of the stock and bond markets. The advantage of using financial development data is that it measures the financial system's main features comprehensively in terms of depth, access, and efficiency, so it contains more information. This measurement is more accurate to overcome the shortcomings of a single indicator as a proxy for financial development. The financial development index is normalized so that the value ranges between 0 and 1, where higher values indicate greater financial depth [15].

The COVID-19 pandemic has caused a weakening of the global financial sector and declined economic growth and output gaps [1, 7, 18]. Lockdown duration policies and strict social restrictions to reduce the spread of the virus resulted in a decrease in aggregate supply and demand [3, 4, 22]. Most industrial sectors experienced a decline in business and a reduction in employees. As a result, people's purchasing power and aggregate demand decreased. This economic shock further results in a decrease in the output gap, economic recession, and weakening of the financial sector. The International Monetary Fund – World Bank Annual Meeting 2021 emphasizes the urgency to implement policies that can overcome and limit the impact of the pandemic (scarring effect) and support global economic transformation. Economic recovery strategies can be carried out through fiscal and monetary stimulus to increase aggregate demand. In terms of monetary policy, the central bank can maintain the benchmark interest rate to reduce recession pressure with a mix of policy and quantitative easing [6]. Changes will follow changes in the benchmark interest rate policy in lending interest rate policies in the same direction. Previous literature states that lending interest rates are significant in financial development [10, 14].

The central bank's monetary policy transmission mechanism can be through bank lending channels. Expansionary monetary policy can increase capital and encourage bank credit offerings, thereby

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increasing aggregate demand to recover the economy [5, 10]. The easing of monetary policy will increase the net interest rate margin and profits, thereby improving the bank's balance sheet condition over time. Additionally, expansionary monetary policy can encourage asset price increases, raising market capitalization and reducing the risk of bad loans [5, 10]. Appropriate interest rate policies and better regulatory quality can encourage the achievement of sustainable financial development, aligning with the G20's priority agenda on the financial path.

One of the most important developments over the past few decades has been the spread of economic policies worldwide. Miranda-Agrippino and Rey [23] mention that the financial policy of a leading country in a region influences the monetary policy of other countries [7, 18]. In this case, there is a spatial linkage between countries. Likewise, countries in the surrounding region will respond positively to the monetary policy of the world's leading central bank. This can happen because these countries are important trading partners. Policy diffusion will be most substantial among the countries concerned [20]. In addition, spillover effects can occur because monetary authorities can implement discretionary monetary policies. This shows that economies worldwide are integrated [5, 19].

Furthermore, the Dynamic Spatial Durbin model approach is used to analyze the spatial spillover effect, considering that the spatial econometric approach to monetary policy has not been widely used. Previous research has emphasized the static spatial approach [19]. The use of this method is significant because the regional aspect affects estimation accuracy through endogenous, exogenous, and error component variables [20]. Additionally, this dynamic spatial approach is used to avoid the problem of biased and inefficient coefficient estimation [5]. In this regard, economic literature has begun to develop various theories to explain spatial spillover interactions between countries.

A quality institutional system and a better legal system promote the development of the financial sector so that it can create new financial regulations and improve financial business services [24]. To maintain the quality of regulation, banks conduct selection on credit requests and monitor their use to avoid the problem of asymmetry of information regarding the feasibility conditions of debtor projects. This is done to prevent the risk of bad loans and avoid adverse selection in credit disbursement [5].

This study aims to analyze the dynamic spatial effect of monetary policy on financial development among ASEAN+3 countries from 2010 to 2020, considering regulatory quality as a control variable. The dynamic spatial Durbin model estimates the spillover effect of monetary policy on financial development. The study also examines whether there is sustainable financial development. Additionally, this study incorporates the impact of the COVID-19 pandemic shock into the model to empirically assess the pandemic's effect on the financial sector.

2. Method

2.1. Data

This study uses data from a panel of original ASEAN member countries and East Asian countries (ASEAN+3) for 2010–2020. The original ASEAN countries consist of Indonesia, Malaysia, the Philippines, Singapore, and Thailand, while East Asian countries include China, Japan, and South Korea (hereinafter referred to as Korea). This group of East Asian countries was chosen because the country's central bank is the world's leading central bank, whose policies have a spillover effect on ASEAN countries.

The data used in this study are annual figures on the financial development index and lending interest rates as a proxy for monetary policy. The study also includes the COVID-19 pandemic shock variable and considers the regulatory quality variable as a control variable [25]. The financial development index comprises the depth (size and liquidity), access (the ability of individuals and firms to access financial services), and efficiency (the ability of institutions to provide financial services at low cost, sustainable income, and capital market activity) of financial institutions and markets. The data originate from several sources, including the International Monetary Fund (IMF), World Development Indicators (WDI), and the Worldwide Governance Indicators (WGI) published by the World Bank.

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Table 1.
Variables, descriptions, and data sources.

Variable	Information	Operational Definition	Unit	Source
FD	financial development	The size of the financial system in terms of depth, access, and efficiency.	Index, located between 0 and 1	IMF
r	Lending interest rates	Bank interest rates to satisfy financing needs.	%	WDI-World Bank
reg	Regulatory quality	The ability of the government to formulate and implement good policies and regulations.	The index is located between -2.5 to 2.5	WGI-World Bank
Covid shocks	Covid shocks	The size of the output gap	US$	WDI-data processed

2.2. Dynamic Spatial Panel Data

A spatial econometric approach is used to measure the relevance of the spatial spillover of monetary policy and lending interest rates to financial development. Monetary policy set by the monetary authority of a leading country will affect the economic performance of other countries in the region. This implies that spatial dependence between countries needs to be considered in the econometric model [20, 23].

Spatial econometrics is a part of econometrics that considers spatial aspects, namely the interconnectedness between regions and variations in regional structures [20, 26, 27]. Following the first law of geography, everything is related to everything else, but closer things are more related than farther away things [28]. The level of financial liberalization in other countries may also influence a country's financial reform. Additionally, nearby countries and those outside the region can be interrelated. These countries are important trading partners [23].

Spatial dependency models are usually modeled first by defining a spatial connectivity matrix [26]. This matrix shows the dependencies between locations, so the size of the spatial weight has an essential influence on the estimation of the spatial dependency model. There are several ways to determine spatial weight. The spatial weighting matrix can be determined based on the proximity of geographical relationships (contiguity) or the weight of distance (distance). The spatial continuity weighting matrix is a matrix based on neighborhood relationships.

Meanwhile, the weighting matrix with the inverse distance method is determined based on the actual distance between locations [7, 20]. The inverse distance matrix assigns larger weights to closer distances and smaller weights to longer distances. Calculating the distance between locations requires latitude and longitude coordinate information from the center point of the observed area.

2.3. Dynamic Spatial Durbin Model (DSDM)

The Dynamic Spatial Durbin model is a spatial model that estimates the interdependence of dependent variables across regions (lag spatial dependence) and the link between dependent variables in one region and independent variables in other areas. The relationship of dependent variables between regions can be written as follows:

$$cov\left[y_i, y_j\right] = E\left[y_i y_j\right] - E\left[y_i\right].E\left[y_j\right] \neq 0,\ \ i \neq j \tag{1}$$

Where i, j shows the observation of the location and is the value of the random variable at that location. The Dynamic Spatial Durbin Model for estimating the spatial spillover of monetary policy on financial developments is as follows [20, 21, 29]:

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

Where t = 1,..., T is the year index, i = 1,..., N is the index that refers to the country being analyzed, k = 1,..., K is the index that refers to explanatory variables, FD_{it} is the financial development in country i during the period t. FD_{jt} is the financial development in country j during the period t . W_{ijt} is n x n spatial weighting matrix. X_{it} is the vector of the independent variable in the country i during the period t. X_{jt} is the vector of an independent variable in state j during the period t. ε is an error term τ, ρ, and η show the parameter response of the lag of the dependent variable in time, *space*, and time-space to test whether the dependent variable is stable [20]. FD_{it-1} is the lag of the dependent variable in time. $W_{ijt}FD_{jt}$ is the lag of the dependent variable in space, $W_{ijt}FD_{jt-1}$ is the lag of the dependent variable in time-space. The equation includes variables that affect FD, namely the lending interest rate (r). The model also includes a control variable, regulatory quality (reg). Furthermore, this study will also analyze the impact of the COVID-19 pandemic shock on the financial development of ASEAN+3 countries.

The Dynamic Spatial Durbin Model (DSDM) in equation (2) shows that spatial dependencies are not only found in dependent variables but also in independent variables. This modeling is based on the influence of spatial dependencies, so it is necessary to conduct spatial dependence testing before modeling. DSDM interpretation requires the calculation of direct, indirect, and total effects [20, 21, 27].

The direct effect captures the effect on financial development in country i caused by changes in exogenous variables in country i. On the other hand, indirect effects can be interpreted as the effects of changes in exogenous variables in all other countries, j ≠ i, on financial development in country i. The total effect is the sum of the direct and indirect impacts. This study uses the maximum likelihood estimation approach to produce consistent parameter estimation. The model will be stable if $\tau + \rho + \eta < 1$ [20, 26]. The consideration of using a dynamic spatial spillover model is to accommodate dynamic monetary policy and anticipate time lag in implementing monetary policy transmission with bank lending channels. In addition, dynamic spatial models allow us to investigate both short-term and long-term effects empirically [21, 29]. The impact of a variable is measured both in the country's territory (direct effect) and in neighboring countries (indirect effect) to improve the understanding of economic phenomena.

Furthermore, the determination of the spatial weighting matrix in this study uses an inverse distance matrix with a cut-off and normalized rows. The Dynamic Spatial Durbin model has overcome the problems of serial correlation, heteroscedasticity, and endogeneity [5, 20, 30].

The COVID-19 pandemic shocks in this study were measured based on the output gap, namely the difference between actual and potential output [31]. The rise and fall of the output gap directly impact economic fluctuations. Furthermore, identifying these gaps can help a country achieve its best performance [32]. A recession occurs when the potential value exceeds the actual value and vice versa. Because potential outputs are difficult to observe in the real world, they are proxied by the expected value. The study used the Hodrick-Prescott (HP) filter to determine the potential output value [31].

3. Results and Discussion

3.1. Descriptive Statistics

Table 2 shows the descriptive statistics of research variables by country group. The sample mean of the financial development index for ASEAN countries is 0.55. Indonesia had the lowest financial development index during the observation period, at 0.29 in 2010. In contrast, Singapore had the highest financial development index of 0.74 in 2017. A standard deviation of 0.17 indicates minimal dispersion from the sample mean.

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Table 2.
Descriptive statistics.

Group	Statistics	FD	r	reg
ASEAN	Mean	0.55	6.47	0.54
	SD	0.17	2.74	0.84
	Maximum	0.74	13.25	2.26
	Minimum	0. 29	3.29	-0.42
East Asia	Mean	0.76	3.51	0.68
	SD	0.13	1.83	0.66
	Maximum	0.92	6.56	1.43
	Minimum	0.51	0.99	-0.29
Total	Rata-rata	0,63	5.36	0.59
	SD	0.19	2.82	0.77
	Maximum	0.92	13.25	2.26
	Minimum	0.29	0.99	-0.42

Note: FD = Financial Development Index; r = Lending Interest Rate; reg = Regulatory quality.

The sample mean for the lending interest rate of ASEAN countries is 6.47 percent. Thailand had the lowest lending rate in 2020 at 3.29 percent, and Indonesia had the highest in 2010 at 13.25 percent. A standard deviation of 2.74 indicates the minimum average dispersion of the sample. The sample mean for the regulatory quality of ASEAN nations is 0.54. In 2010, Indonesia exhibited the lowest regulatory quality at -0.42, whereas Singapore demonstrated the best regulatory quality in 2015 at 2.26. The standard deviation of 0.84 indicates a large dispersion between countries from the sample mean of 0.54. Comparatively, East Asian countries have an average financial development index of 0.76. High regulatory quality in developed countries encourages high financial development. In general, East Asian countries have a higher average value in the financial development index than ASEAN countries, while lending rates tend to be low. The quality of regulation in East Asia also has a high average institutional score of 0.68.

3.2. Financial Developments and Monetary Policy in ASEAN+3

Figure 1 presents the financial development index for ASEAN and East Asian countries. Indonesia and the Philippines' financial development indices are lower than those of other ASEAN countries. This indicates that the condition of financial development in Indonesia and the Philippines is still below the average of ASEAN countries. In 2010, Indonesia's financial development index was 0.29, while the average of ASEAN countries was 0.55. From 2013 to 2020, Indonesia's financial development increased by 0.36. This is because there has been a significant increase in the depth, access, and efficiency of financial institutions in Indonesia.

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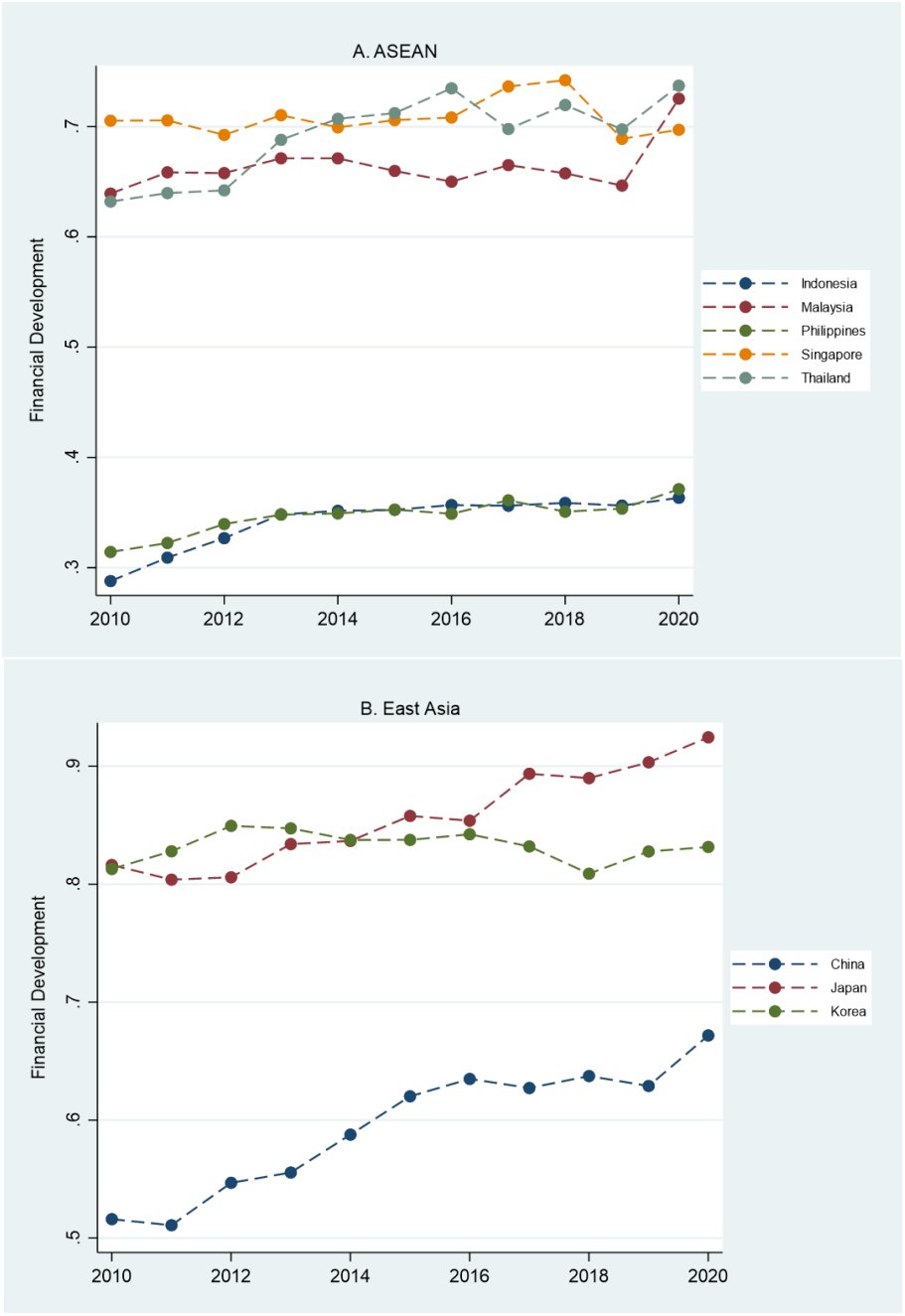

Figure 1.
Financial Development of ASEAN and East Asian Countries, 2010-2020.

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Financial institutions and financial markets, indicators of financial development in the Philippines, still show figures below the average of ASEAN countries. The level of depth, access, and efficiency of financial institutions in the Philippines is lower than that of the financial markets. Meanwhile, financial development has been relatively advanced in Thailand, Singapore, and Malaysia, which is above the average of ASEAN countries. In 2020, Thailand's financial development index was 0.74, while Singapore's and Malaysia's were 0.70 and 0.73, respectively. The study results show that the COVID-19 pandemic weakened the financial sector by up to 7 percent.

In the East Asian region, Japan and Korea have more advanced financial development than China (Figure 1B). The average level of financial development in Japan and Korea is 0.85 and 0.83, respectively. Meanwhile, in China, it is 0.59. From the figures, it can be seen that there was significant financial development during the observation period. Financial institutions' depth, access, and efficiency development contribute considerably. The evolution of the financial development index during 2010-2020 reflects rapid growth in the financial system in both ASEAN and East Asia.

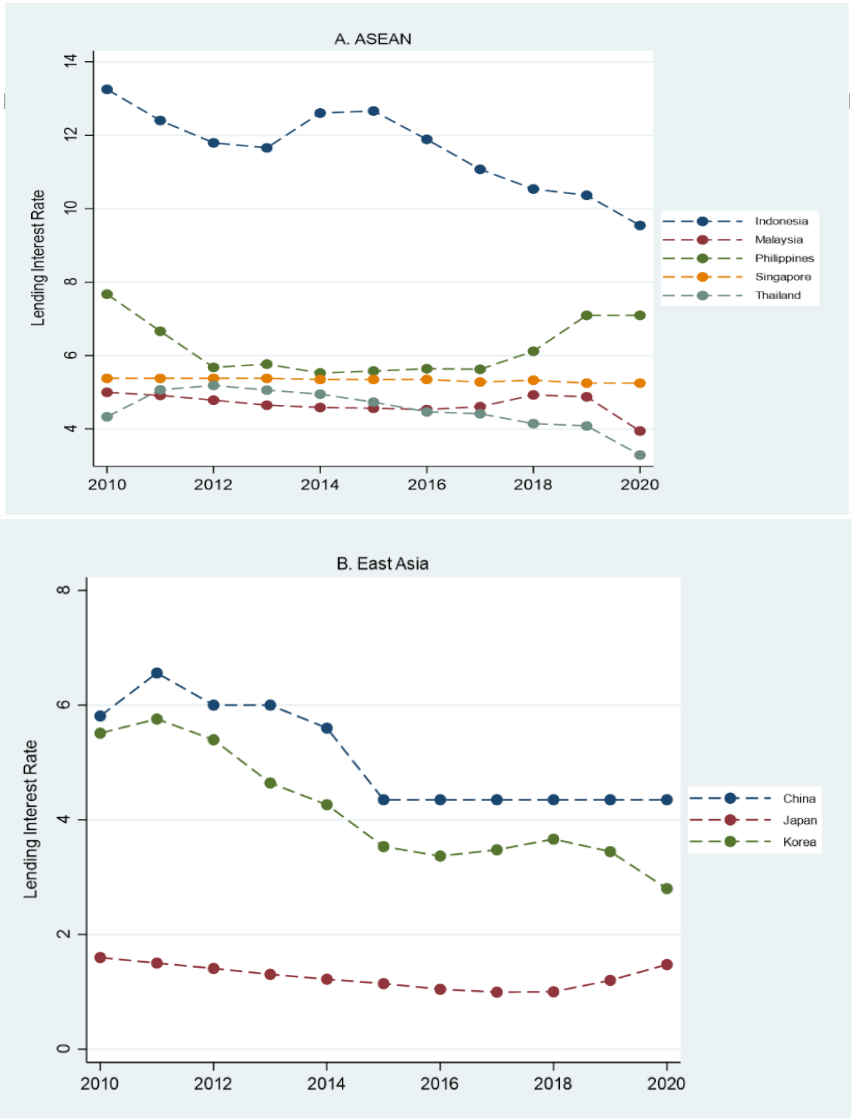

Figure 2.
Trend of Lending Interest Rates of ASEAN and East Asian Countries (Percent), 2010-2020

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Figure 2 shows the lending rate development in ASEAN and East Asia from 2010 to 2020. Indonesia has the highest lending interest rate among ASEAN+3 countries, at 11.62 percent. Meanwhile, Japan has the lowest average lending rate of 1.26 percent. It can be seen that the average lending rate in ASEAN decreased toward 2020 as a response to the monetary policy of the world's leading country. This condition is followed by the development of the financial sector, making it more open to achieving sustainable financial development [5].

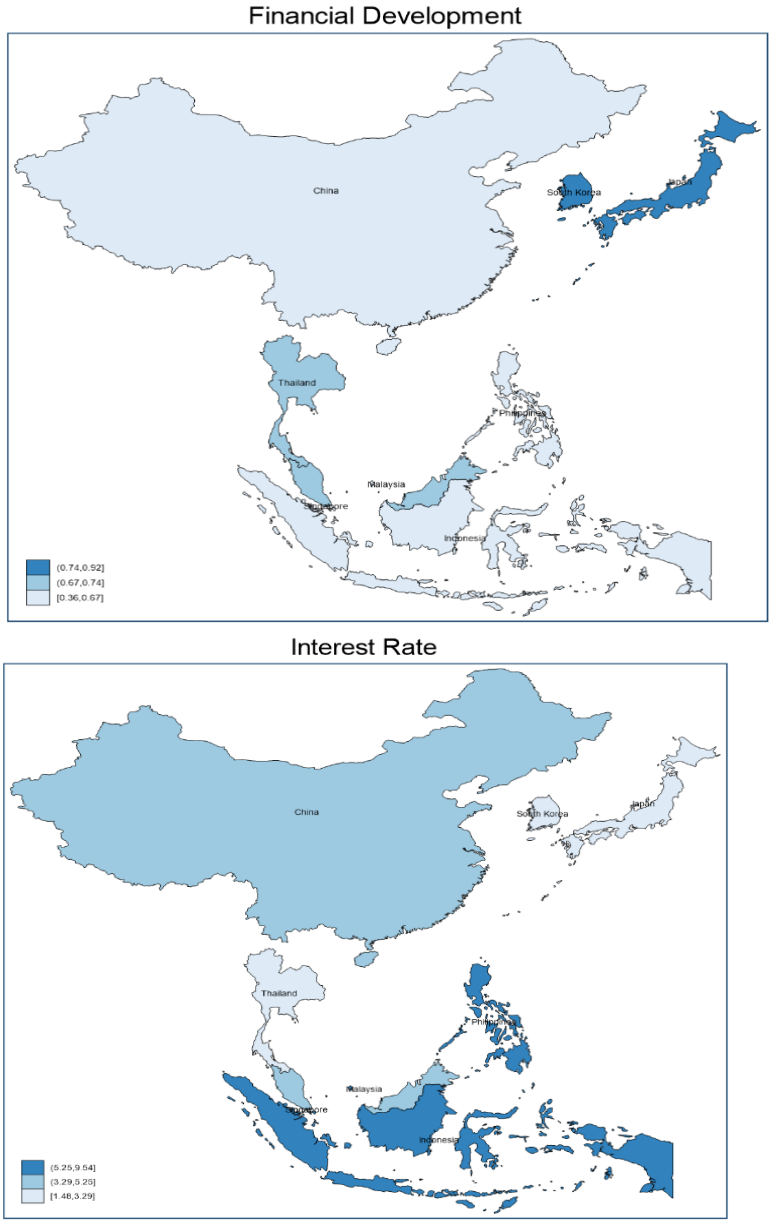

Figure 3.
Geographical Location of Financial Development and Interest Rates, 2020.

A map of the spatial grouping of financial developments and lending interest rates is shown in Figure 3. It can be seen that financial development in ASEAN+3 is spatially linked; regions with high levels of financial development have nearby countries that also have high levels of financial

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development, and vice versa. In particular, it appears that Japan and Korea have close locations, and both have a high financial development index, which is located in the group between 0.74 and 0.92. Likewise, the countries' lending rates tend to be low, at between 1.48 percent and 3.29 percent.

Meanwhile, Indonesia and the Philippines had the lowest financial development indices in 2020, at 0.36 and 0.67, respectively, with the highest lending interest rates at 5.25 percent and 9.54 percent. Figure 3 illustrates the potential spillover effect of policies by the world's leading monetary authorities on the financial development of regional countries [23].

3.3. Dynamic Spatial Durbin Model Estimation

Table 3 shows the results of the DSDM estimation using an inverse-distance matrix with *a cut-off* of 4200 km, considering the distance between ASEAN+3 countries. Column 1 shows the coefficient of the estimated spillover effect of monetary policy, namely the lending interest rate on financial development (Model 1). Furthermore, the impact of the COVID-19 pandemic on the financial development of ASEAN+3 countries is shown in Model 2. This DSDM model also includes time-invariant control variables, namely the regulatory quality [25, 33]. The estimated results are shown in Model 3. DSDM models are proven to be stable because $\tau + \rho + \eta < 1$ so that the resulting parameters are consistent [20].

Furthermore, the DSDM model estimates also provide information on the direct, indirect, and total effects of the COVID-19 pandemic shock and control variables. The indirect impact differs from the Wr coefficient. This difference is caused by feedback effects from impacts passing through other countries and returning to the country [21].

The coefficient estimation for the lag of the dependent variable in time (FD(-1)) demonstrated positive and statistically significant findings across all models. This indicates that the state of financial development in the previous period positively influences the financial development of the current period. There is a discernible phenomenon of financial development in Indonesia and other ASEAN+3 nations. The study found that more banking facilities and other financial institutions are being developed yearly than in the previous year.

The spatial lag parameter (ρ) has a positive and significant value of 0.192 for Model 1. Meanwhile, for Model 2, it is 0.337; for Model 3, it is 0.301. This indicates that financial development in a country correlates with financial development in the surrounding region.

Table 3.
Dynamic Spatial Durbin Model Estimation Result, 2010-2020.

Variables	**Coefficient**		
	(1)	**(2)**	**(3)**
FD(-1)	0.713***	0.772***	0.747***
	(0.056)	(0.050)	(0.063)
WFD (-1)	-0.684***	-0.286**	-0.879***
	(0.177)	(0.125)	(0.211)
r	-0.009**	-0.007*	-0.008**
	(0.004)	(0.004)	(0.003)
Wr	-0.045***	-0.036***	-0.040***
	(0.009)	(0.008)	(0.009)
Covid shocks		-0.340***	
		(0.117)	
Wreg			-0.124***
			(0.029)
Spatial (ρ)	0.192**	0.337***	0.301***
	(0.75)	(0.114)	(0.060)
SR_direct r	-0.007*	-0.004	-0.006*
	(0.004)	(0.003)	(0.003)
Covid shocks		0.090	
		(0.169)	

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	reg			-0.022*
				(0.013)
SR_indirect	r	-0.038***	-0.025***	-0.030***
		(0.007)	(0.004)	(0.006)
Covid shocks			-0.278**	
			(0.133)	
	reg			0.106***
				(0.022)
SR_total	r	-0.045***	-0.030***	-0.036***
		(0.010)	(0.006)	(0.008)
Covid shocks			-0.187**	
			(0.073)	
	reg			0.084***
				(0.023)
LR_direct	r	-0.065	-0.229	-0.006
		(0.231)	(4.305)	(0.449)
Covid shocks			-5.500	
			(107.426)	
	reg			0.036
				(1.972)
LR_indirect	r	0.020	0.183	-0.027
		(0.230)	(4.306)	(0.449)
Covid shocks			5.213	
			(107.430)	
	reg			0.040
				(1.971)
LR_total	r	-0.046***	-0.046***	-0.033***
		(0.010)	(0.008)	(0.007)
Covid shocks			-0.288***	
			(0.110)	
	reg			0.076***
				(0.021)
No. of observations		80	80	80
No. of countries		8	8	8
R^2		0.988	0.990	0.967
Log-pseudolikelihood		224.787	226.781	225.221

Note: Statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Robust standard error in parentheses.

In this case, there is competitiveness between countries, where the financial performance of a country will be better if the financial performance of neighboring countries in one region performs well.

Furthermore, the study results show that lending interest rates negatively and significantly influence financial development in all models. The results support previous research [10, 14]. The negative effects are persistent in both short-term and long-term totals. Government regulations related to monetary policy are implemented to maintain financial system stability. The negative and significant Wr of -0.040 indicates a negative diffusion spillover effect from the monetary policy of the world's leading central banks on the financial development of regional countries, considering regulatory quality as a control variable (Model 3). The results support the results of previous research by Miranda-Agrippino and Rey [23]. These results are driven by significant indirect effects in the short term and significant total effects in both the short and long term.

The contractionary lending rate policy implemented by the monetary authorities of the world's leading countries will weaken the conditions of domestic financial development due to the domestic central bank's response to the policy. These results reinforce the empirical relevance of spatial spillovers in this context [23]. This condition requires serious attention from the Deposit Insurance regarding the beginning of an increase in credit risk. The study results are consistent with a highly interdependent economic environment, where changes across countries interacting in the system are more relevant than

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changes in single countries. To achieve sustainable financial development, it is necessary to maintain an expansionary monetary policy because the total spatial effect of monetary policy is significant in the short and long term, as stated in the theory [10].

The COVID-19 pandemic has significantly weakened the financial sector [1]. Social restrictions or lockdown policies limit economic activities that affect the financial ability of business actors and society in general. This can increase credit risk and the threat of banking default [2, 5]. The negative effects of the economic crisis will still be felt in the long term. The economic recovery process is gradual and varies between countries. Countries with strong and stable economic conditions typically experience economic recovery more rapidly than those with weaker economies, as high vaccination rates facilitate the quicker establishment of herd immunity. Investor confidence in increasing cross-border stock trading begins to grow [2].

Regulatory quality can improve financial business services to avoid adverse selection and moral hazard [24]. In Model 3, the total effects of regulation are positive and significant in both the short and long term. Regulatory quality's direct and indirect effects are more prominent in the short term.

3.4. Robustness Test

Table 4 shows that the results of the robustness test estimated with a shorter panel look consistent with the leading results [33]. A spatial spillover effect of monetary policy on financial development was indicated by negative and significant coefficient values in Model 4, Model 5, and Model 6, of -0.052, -0.041, and -0.048, respectively. The monetary policy of the world's leading central bank will be responded to by the central banks of countries in the region [23].

Table 4.
Empirical results of robustness test, Dynamic Spatial Durbin Model, 2014-2020.

Variables		Coefficient		
		(4)	**(5)**	**(6)**
FD(-1)		0.431**	0.507**	0.518**
		(0.213)	(0.202)	(0.226)
WFD (-1)		-0.885***	-0.401	-0.795***
		(0.283)	(0.161)	(0.248)
r		-0.011**	-0.008**	-0.012***
		(0.005)	(0.004)	(0.004)
Wr		-0.052**	-0.041***	-0.048***
		(0.005)	(0.014)	(0.018)
Wcovid shocks			-0.329**	
			(0.155)	
Wreg				0.119**
				(0.052)
Spatial (ρ)		0.385**	0.567***	0.456***
		(0.018)	(0.104)	(0.155)
SR_direct	r	-0.008**	-0.005*	-0.009***
		(0.003)	(0.003)	(0.003)
Covid shocks			0.124	
			(0.206)	
	reg			-0.038
				(0.032)
SR_indirect	r	-0.037***	-0.025***	-0.032***
		(0.011)	(0.008)	(0.010)
Covid shocks			-0.279	
			(0.187)	
	reg			0.097**
				(0.046)
SR_total	r	-0.046***	-0.030***	-0.040***
		(0.013)	(0.010)	(0.011)

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Covid shocks			-0.154***	
			(0.045)	
	reg			0.059**
				(0.025)
LR_direct	r	-0.004	0.003	-0.159
		(0.472)	(0.009)	(3.999)
Covid shocks			0.497	
			(0.806)	
	reg			2.020
				(55.072)
LR_indirect	r	-0.030	-0.036**	0,125
		(0.472)	(0.15)	(3.999)
Covid shocks			-0.663	
			(0.785)	
	reg			-1.970
				(55.072)
LR_total	r	-0.034***	-0.033***	-0.034***
		(0.010)	(0.010)	(0.010)
Covid shocks			-0.166***	
			(0.048)	
	reg			0.050**
				(0.021)
No. of observations		56	56	56
No. of countries		8	8	8
R^2		0.983	0.986	0.898
Log-pseudolikelihood		135.205	136.285	134.965

Note: Statistical significance: *** p < 0.01, ** p < 0.05, * p < 0.1. Robust standard error in parentheses.

Monetary authorities can issue regulations to create sustainable financial development by establishing the expansion of monetary policy [8, 10]. As shown in Table 4, the linkage between monetary policy and financial developments is significant in the long term. Furthermore, the robustness test results on DSDM proved stable because $\tau + \rho + \eta < 1$, so the parameters produced were consistent.

4. Conclusion

This study analyzes the dynamic spatial effect of monetary policy on financial development among ASEAN+3 countries from 2010 to 2020, considering regulatory quality as a control variable. It also examines whether there is sustainable financial development. The COVID-19 pandemic shock is included in the model to empirically estimate its impact on the financial sector. The model used is the Dynamic Spatial Durbin (DSDM) model, which accounts for spatial dependence between countries and produces consistent parameters.

The results show a negative and significant total spatial spillover effect of monetary policy on lending rates and financial development when regulatory quality is considered a control variable, both in the short and long term. The DSDM model indicates that sustainable financial development can be achieved in the long term if the monetary authority expands its monetary policy on lending rates. Studies also show that financial developments in the past positively affect current financial developments. Additionally, financial development in a country is correlated with financial development in surrounding countries. Furthermore, the shock of the COVID-19 pandemic has significantly harmed financial development, and indirect negative effects in the short term have caused this effect.

Negative and significant spatial spillovers indicate that some form of policy coordination (policy mix) should be implemented to promote sustainable financial development and reduce inefficiencies. This policy can serve as one of the exit strategies to mitigate the COVID-19 pandemic's scarring effects on the national economy. The study aims to expand by including the role of the United States Fed, as a leading global country, in analyzing the spatial effects of monetary policy on the financial development of other countries in the region.

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Transparency:

The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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