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Uneven Growth and Financial Inclusion in Morocco:

A Spatial Analysis of Regional Economies.

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Abstract. The implementation of financial inclusion and the promotion of economic growth are struggling to overcome certain challenges, notably the spatial factor. This paper examines the relationship between regional financial inclusion and regional economic growth across Morocco's 12 regions over the period 2015–2021. A composite financial inclusion index is constructed. The spatiotemporal characteristics of financial inclusion and economic growth are analyzed using Moran's I statistic to detect the presence of spatial autocorrelation. The Spatial Durbin Model (SDM) is adopted after many tests. Results support the positive relationship between regional financial inclusion and regional economic growth. Spatial autocorrelation between the two variables is statistically significant. The results not only reveal the importance of financial inclusion in promoting regional economic growth, but also highlight the need for further research into the issue of spatial inequalities.

Keywords: Fintech; spatial econometrics; financial inclusion; economic growth.

JEL Classification : G21, R11, C21.

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1 Introduction

Over the last two decades, Morocco has embarked on an ambitious project aimed at improving household quality of life and promoting regional economic growth

Morocco's regional, spatial, and economic structure is diverse; encompassing three main sectors: agriculture, industry, and tourism. The Casablanca-Settat, Rabat-Salé-Kénitra, and Tanger-Tétouan-AlHoceima regions are well developed areas with established infrastructure and geographical proximity to Europe. The Casablanca-Settat region also hosts a wide range of industries, particularly textiles, making it the wealthiest region in the country. However, this concentration of GDP in certain regions reflects a deepening of spatial disparities. To address this, Morocco has introduced inclusive financial policies aimed at reducing marginalisation in access to and use of financial services, and at integrating all regions into a shared development path.

Financial inclusion is defined as the process of ensuring equitable access to financial services for impoverished and low-income groups at an affordable, fair, and transparent cost (Kochhar, 2009), while also maximising access and effective use by minimising involuntary financial exclusion (Cámara & Tuesta, 2014) .

A World Bank survey conducted in 2017 found that 41% of Moroccan adults use a formal financial product or service, placing Morocco above the average level of financial inclusion in the MENA region. This finding reflects significant progress in access to and use of financial services at the national level; however, the question remains whether this rate reflects equitable access and use across Morocco's 12 regions, particularly the least developed ones.

Morocco has made significant progress in financial inclusion at the national level; however, progress remains limited at the regional level, where certain regions such as Draa-Tafilalt and Oriental remain marginalised, giving rise to spatial disparities. This concern was notably expressed by His Majesty King Mohammed VI: "The Morocco of today and tomorrow cannot accept a two-speed development" (Throne Speech, 2025).

In 2019, Morocco's economic landscape was characterised by a sharp concentration of GDP, with only three regions accounting for 58% of national wealth. The Casablanca-Settat region also recorded the highest level of financial inclusion. These observations collectively highlight the persistence of spatial disparities.

The relationship between finance and economic growth continues to attract considerable scholarly attention. The work of (Goldsmith, 1969),(McKinnon, 1993) and (Gurley & Shaw, 1955) demonstrated a positive link between financial development and economic growth. The work of (Emara & El Said, 2021) highlighted the importance of institutions and good governance in achieving financial inclusion and its impact on economic growth. (Hariharan & Marktanner, 2012) found that financial inclusion influences economic growth.

The study aims to address this question by integrating the spatial approach, enabling a better understanding of spatial interactions between regions with respect to financial inclusion and economic growth, and to detect the link between the two. The findings of the present study reveal three main observations. First, a positive and statistically significant spatial autocorrelation of

GDP and the financial inclusion index. Second, a positive correlation between financial inclusion and economic growth. Third, a spatial proximity effect, whereby promoting growth in one region can influence the level of growth in neighbouring regions. The integration of a spatial model made it possible to detect spatial effects among regions in terms of both economic growth and financial inclusion. These results reveal the added value of the spatial approach for policymakers in designing interregional development plans capable of integrating all segments of society into the economic fabric. The study proceeds as follows: first, a spatial weighting matrix, w_{ij}, is constructed to define the neighbourhood structure and capture spillover effects, drawing on three types of weighting matrices, the Queen matrix, the Rook matrix, and the distance matrix. Second, the Moran index is used to detect spatial autocorrelation. Finally, the spatial model is validated and its design discussed.

This paper is structured as follows. First, a literature review identifies the link between financial inclusion and economic growth. This is followed by a presentation of the methodology and empirical approach, covering the following steps: determination of the neighbourhood matrix, spatial correlation and specification tests, estimation and interpretation of the spatial econometric models. Next, the results are presented and discussed. Finally, a conclusion is drawn.

2 Literature review

2.1 The concept of financial inclusion.

Financial inclusion is defined as an important factor in ensuring equitable access to financial services for the impoverished and low-income groups at an affordable, fair, and transparent cost (Kochhar, 2009)(Cull et al., 2009); it reflects access to financial services and their effective use (Demirguc-Kunt et al., 2018). Others define financial inclusion by referring to the exclusion aspect; according to (mohan, 2006), financial exclusion reflects the lack of access of certain segments of society to formal financial products and services.

2.2 Indicators measuring the IFI

Previous literature seeks to develop approaches to assess financial inclusion by constructing an index of financial inclusion (IFI). (Sarma, 2008) developed a financial inclusion index based on three dimensions: banking penetration measured by the number of bank accounts as a proportion of the total population, availability of banking services determined by the number of bank branches per 1,000 inhabitants, and usage measured by the volume of bank credit and deposits as a percentage of GDP. In the same vein, ((Kablana) & Chhikara, 2013) adopted three dimensions to better determine the level of financial inclusion: bank penetration measured by the number of bank accounts per 1,000 adults, availability measured by the number of branches and ATMs per 100,000 inhabitants, and usage measured by loans granted and deposit volume relative to gross domestic product (GDP). The approach adopted by (Ezzahid & Elouaourti, 2021) is based on two dimensions: access to and use of financial services. The first dimension reflects access to formal financial services, while the second reveals the actual use of these financial services.

2.3 The theoretical framework.

The relationship between finance, and financial inclusion in particular, and economic growth is still at the heart of the theoretical debate. The Schumpeterian approach and the framework developed by (Beck & Demirgüç-Kunt, 2008) (King & Levine, 1993a) support the positive relationship between finance and economic growth, explained by the positive effect of financial intermediation on wealth creation. They showed the importance of financial intermediaries and the effect of the interest rate to promote investment through two channels, the accumulation of capital and the increase in the savings rate, which affects economic growth. The theory of financial liberalisation, developed by (McKinnon and Shaw in 1973), emphasises the importance of financial development in promoting growth through investment by expanding the supply of credit. Other works, notably Minsky (Minsky, 1964), identify the negative link between finance and economic structure caused by banking intermediation operations, which influence financial instability.

In this context, and to better explain the link between financial inclusion and economic growth (Bashier et al., 2022) in a social neo-capitalism context, we draw on two theoretical hypotheses: supply (HSL) and demand (HDL). The SSH posits that financial inclusion acts as a lever for economic growth by stimulating productivity through the creation and innovation of financial services, which in turn drives demand. The DDH considers financial inclusion to be a consequence of economic growth, whereby financial inclusion develops to meet expressed needs and subsequently generates growth.

From this supply and demand perspective, and based on an analysis of the links between finance and economic growth, several studies have shown that limited access to financial services can widen income disparities, which in turn can affect growth in developing countries (Serrao et al., 2012). (Inoue & Hamori, 2016), in a study covering 37 African countries over the period 2004–2012, report that financial inclusion, measured by the number of bank branches, has a positive impact on economic growth. (Swamy, 2012) and (Danilov, 2019) confirm that increased financial resources often contribute to a higher rates of economic growth.

(Siddiki & Bala-Keffi, 2024) analysed the relationship between economic growth and financial inclusion using data from 153 countries; the results showed that financial inclusion stimulates economic growth, although the degree of impact varies between developed and developing countries. (Emara & El Said, 2021), used the GMM approach with data from the MENA region to demonstrate the impact of financial inclusion on GDP per capita growth. Other empirical studies have highlighted the issue of unidirectional and bidirectional causality.

Studies suggest a unidirectional causal relationship running from financial inclusion to economic growth (Emara & El Said, 2021).(Sethi & Sethy, 2018) demonstrated a long-term relationship between economic growth and financial inclusion, characterised by a one-way causal relationship from financial inclusion to economic growth, validated by Granger tests. (Pradhan & Sahoo, 2021), for the case of India over the period 1991–2018, demonstrated a long-term unidirectional causality from economic growth to mobile phone penetration, used here as a proxy for financial inclusion. (Odame et al., 2024), in the case of Ghana, find that overall financial inclusion has a negative unidirectional relationship with growth, while a bidirectional causal relationship indicates that actual financial penetration stimulates GDP.

Other studies reveal a bidirectional relationship. (Sethi & Acharya, 2018), based on data from 31 countries, demonstrate a bidirectional causal relationship between financial inclusion and economic growth. (Kim et al., 2018a) show, for the Organisation of Islamic Cooperation (OIC) countries, the existence of a bidirectional causal relationship between financial inclusion and economic growth, validated by Granger causality tests. (Erlando et al., 2020)), using the Panel Vector Autoregression model and the Toda-Yamamoto VAR bivariate causality model to analyse the link between financial inclusion and economic growth, income distribution, and poverty in eastern Indonesia, demonstrated a bivariate causality. (Gourène & Mendy, 2019) indicated a bidirectional causal relationship in the long and medium term, although for periods of less than 4 years, no causality was found between the two variables. (Jima & Makoni, 2023) adopted the PCA method to construct the IFI in order to study the relationship between financial inclusion and economic growth using panel data from 26 Sub-Saharan African (SSA) economies; the study revealed a long-term bidirectional causality.

The incorporation of spatial effects is gaining prominence in the study of the relationship between financial development, financial inclusion, and economic growth (Sun & Tu, 2023; Wang et al., 2019; Wu & Gu, 2019). (Erra & Acharya, 2021), incorporating exploratory spatial data analysis (ESDA) for the Indian context, examine the spatial dependence of financial inclusion and provide relevant implications for policymakers and bankers seeking to target financial inclusion schemes in underdeveloped states.

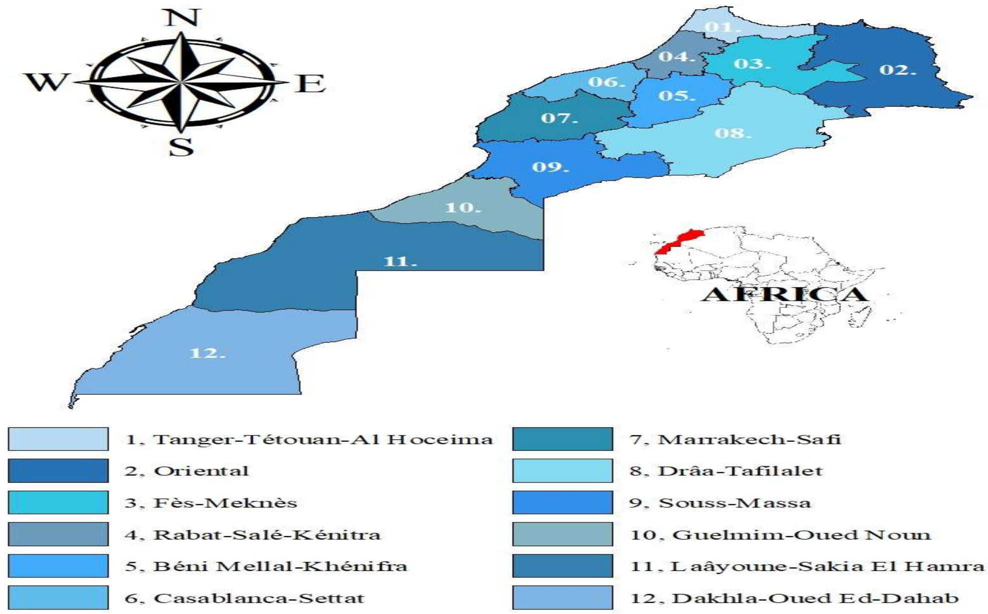
In light of studies demonstrating the relationship between economic growth and financial inclusion, this study aims to address a significant gap in this area of research by incorporating the spatial dimension. Three objectives are pursued: to test the relationship between economic growth and financial inclusion; to identify the spatial effects of promoting growth and stimulating financial inclusion; and to assess the relevance of a financial inclusion strategy across the different regions of Morocco.

3 Data and variable selection

3.1 Data

The 2015 territorial reorganisation is part of the ambitious project to establish the foundations of advanced regionalisation, announced by the Kingdom in 2011, with the aim of integrating all regions into a development trajectory and promoting regional economic growth. Inclusive growth requires a more equitable distribution of wealth and deeper integration of regions into the financial system. It is therefore necessary to account for spatial characteristics among regions in order to better understand the contribution of financial inclusion to regional economic growth and to formulate an effective strategy for financial and economic inclusion.

Figure 1. Map of study area: Regions of Morocco.



Source: author's own.

Economic growth in Morocco is concentrated in three major regions, giving rise to significant disparities in regional equality. Financial inclusion is a key factor of economic growth and human development. Indeed, it promotes entrepreneurship, investment, and poverty reduction. Examining this relationship requires the mobilisation of several variables and spatial empirical approaches. The choice of variables is guided by theoretical considerations, as well as empirical studies in the field, notably (Bjork, 1999),(Kim et al., 2018a), and(Wu & Gu, 2019). Data are collected from several sources, including Bank Al-Maghrib and HCP annual reports. The variables included in the analysis are: gross domestic product (expressed as a logarithm); the human capital index, expressed as the ratio of the number of secondary school students to the total population (in percentage); the labour force participation rate; household final consumption expenditure (expressed as a logarithm); and the urbanisation rate, measured as the ratio of the urban population to the total population. The data cover the period 2015–2021 for Morocco's 12 regions, with this period determined by the availability of data for the selected variables.

Table 1. Description of the explanatory variables.

Variables	Definition	Source
A. Dependent variable:		
LGDP	GDP (Gross Domestic Product rate)	High Commission for Planning (HCP)
B. Independent variable and control variables		
IFI	Index of Financial Inclusion (IFI)	Bank Al-Maghrib
UR	urbanisation rate	HCP
HCI	Human Capital Index (HCI)	HCP
HFCE	Household Final Consumption Expenditure (HFCE)	HCP
AR	Labour force participation rate	HCP

3.1.1 Constructing a Regional Index of Financial Inclusion for Morocco

Several variables are likely to explain the level of financial inclusion. Based on the work of (Ezzahid & Elouaourti, 2021), the financial inclusion index constructed in this study relies on two dimensions. The first is the access dimension, which reflects the availability of financial services, represented by the number of branches per region and the number of commercial branches per region. The second is the utilisation dimension, measured by loans granted by region and the share of savings in commercial bank deposit accounts by region.

***Data normalisation*:** The normalisation method is based on the min-max principle, which makes the indicators comparable. The formula developed by (Sarma, 2008) follows the same approach.(Sarma & Pais, 2011); after identifying the dimensions of the index, assign the following weights: 1 for the accessibility dimension (penetration), 0.5 for the availability dimension, and 0.5 for the usage dimension. The method adopted by (Ezzahid & Elouaourti, 2021), by contrast, is based on a scientific approach that calculates the contribution of each sub-indicator (explained variance) to the calculated financial inclusion index, using principal component analysis.

The index of dimension i sub-indicator; *di*, is calculated using the following formula:

$$d_{i}= \frac{A_{i-mi}}{Mi-mi} \quad (1)$$

With:
di: normalised value of sub-indicator i
Ai: actual value of sub-indicator i, A=(ATMs, LOANS, DEPOSITS, BRANCHES)
mi: minimum observed value of sub-indicator i,
Mi: maximum observed value of sub-indicator i,
The first step is to determine the weights of each indicator. The use of principal component analysis is strongly justified by the nature of the correlation between the sub-indicators, which captures the collinearity among them.

According to the Appendix 2 above, the correlation between the various sub-indicators of financial inclusion is strong, exceeding 0.83, suggesting that principal component analysis is appropriate for reducing the four sub-indicators to a single composite index.

Data aggregation and calculation of IFI: After calculating the dimension index for each indicator, we use the principal component analysis method to determine the weight (wi) of each dimension of financial inclusion, in order to minimise the bias towards highly correlated indicators, based on the explained variance principle (Giovanni et al., 2005). The contribution of each indicator to the financial inclusion index is as follows:

$$\mathrm{w_{ij}} = \frac{\text{coefficient of variation}_{\mathrm{ij}}}{\sum_{\mathrm{j}} \text{coefficient of variation}_{\mathrm{ij}}} \quad (2)$$

$\sum_j \boldsymbol{coefficient\ of\ variation_{ij}}$: is the total variance measured by the sum of the eigenvalues in the table of explained variance (appendix 1).

The following table shows the weights of the sub-indicators and dimensions obtained from the rotation coefficient matrix. The dimension of access has a higher weight than the dimension of use, reflecting its greater importance in explaining financial inclusion.

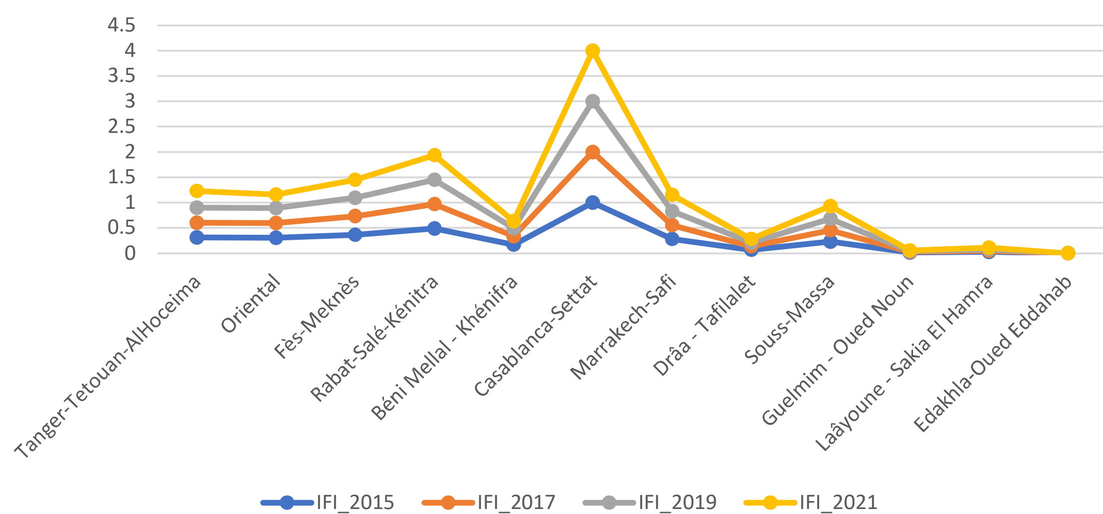
The financial inclusion index is presented as follows:

$$\boldsymbol{IFI} = \sum_{i=1}^{q} w_i d_{ri}, (3)$$

- The variable is double-indexed: a first index “r” represents each Moroccan region and a second index “i” represents each sub-indicator constituting the financial inclusion index.

The correlation matrix of the indicators reveals a very strong correlation (Appendix 2). To verify the robustness of our indicator, two highly correlated indicators were excluded and an alternative IFI was recalculated. The correlation between the IFI and the alternative IFI (**IFI_alt**) is very strong (Appendix3). The re-estimated SDM model (table 6), using the alternative IFI and the lagged alternative IFI, shows high consistency with the baseline SDM. This demonstrates that the financial inclusion index is not sensitive to indicators that contribute little.

Figure 2. Distribution of IFI by Region, year 2015-2017-2019 and 2021



During the 2015–2021 period, the Casablanca-Settat region exhibited high levels of financial inclusion, while the Rabat-Salé-Kénitra and Marrakech-Safi regions recorded average levels. In contrast, the southern regions exhibited low level of financial inclusion. These findings highlight significant challenges, notably disparities in financial inclusion across Morocco's regions; disparities that are typically overlooked by traditional econometric approaches.

3.2 Variable selection

The strong interdependence between explanatory variables generates multicollinearity in a regression model, which can lead to misleading studies and misinterpretations (Mason & Perreault, 1991). The variance inflation factor (VIF) test is used to detect multicollinearity. Therefore, to ensure the most appropriate variables in the OLS model, values with a VIF greater than 10 will be removed (Appendix 4). Next, the correlation test is performed. The homoscedasticity test performed on the OLS model residuals is the Breusch-Pagan test. The test shows a value of 0.2480, which exceeds the 10% significance level, indicating the existence of homoscedasticity.

In order to analyse the link between economic growth and financial inclusion, the study incorporates several control variables. GDP is used as the endogenous variable, while the financial inclusion index and the urbanisation rate, the level of education, final household consumption at current prices and the labour force participation rate as macroeconomic control variables (Elhorst, 2010),(Bjork, 1999) and (Mankiw, 2012). Dummy variables are included to account for the shock effect of the COVID-19 pandemic over the period 2020–2021.

4 Methodologies

The methodology of this study is structured around two parts. The first consists of an exploratory analysis of the data using spatial mapping to summarise information in an accessible and easily interpretable manner. The second focuses on estimating a spatial model to better analyse the nature of the relationships between the selected variables.

Prior to estimation, the study employs a spatial weights matrix based on the Queen contiguity matrix, in order to identify the most appropriate model for detecting spatial effects among the different aggregates. The SEM, SAR, SDM, and DSDM (dynamic SDM) spatial models are estimated and compared in terms of goodness of fit and their capacity to account for the spatial dependence previously detected. The Akaike (AIC) and Bayesian information criterion (BIC) are used to check the quality of fit and robustness of the models, as suggested by (LeSage & Pace, 2009) and (Elhorst, 2014). The lower the AIC value, the more appropriate the analysis method.

Another crucial methodological consideration concerns potential endogeneity, which could affect the robustness of the results. Robustness is verified using two approaches: the first-order lag terms method from the financial inclusion index (Zhou and Xu, 2022) and re-estimation of the baseline model using the distance matrix.

The spatial model validated and adopted for analysing the relationship between economic growth and regional financial inclusion is the SDM. ArcMap 10.7 and GeoDa software were used to present the variables and analyse spatial autocorrelation. The Stata command `xsmle` was used to design the spatial model (Belotti et al., 2017).

4.1 Conception matrix

The first step in the detection of autocorrelation is to establish the weighting matrix. The methods used to design the spatial weighting matrix, i.e. the Queen contiguity matrix, the Rook contiguity matrix, and the distance matrix, are used to explain the spatial relationship between different geographical areas. Two types of matrices were designed: a Queen contiguity matrix and a distance matrix.

The spatial matrix is based on the distance matrix weighted by the negative exponential function used to standardise the spatial weights. By adopting the following formula:

$$f(d_{ij}) = e^{-2d_{ij}}$$

$$w_{ij} = f(d_{ij}) \tag{4}$$

$$\begin{cases} W_{ij} = e^{-\alpha d_{ij}}; \forall i \neq j \\ W_{ii} = 0 \end{cases} \tag{5}$$

$\boldsymbol{d_{ij}}$: is the distance between the center of region i and the center of region j (in kilometers).$\boldsymbol{w_{ij}}$ is the spatial weight representing the influence of region i on region j.α:Spatial decay parameter. $W_{ij>0}$ if regions i and j are neighbouring (or close), and $W_{ii} = 0$ otherwise.

The Queen contiguity matrix identifies neighbours as spatial units that share at least one border point, including diagonal neighbours. The Rook contiguity matrix, by contrast, considers only units that share at least one full edge, making it more restrictive in defining neighbourhood relationships. Following the construction of the weights matrix, the next step involves detecting the degree of spatial autocorrelation.

4.2 Spatial autocorrelation measurements

The spatial aspect in this study reflects not only the geographical link but also the spatial relationship of the research topic. The Moran's I statistic is computed using a spatial weights matrix of order (N×N), which assigns weights to regional values and captures the spatial relationships between geographical areas represented by W.

The Moran's I statistic takes values between −1 and 1. If the value is close to 1, this indicates positive spatial autocorrelation, whereas a value of 0 reflects the absence of spatial autocorrelation. If the value is close to −1, the autocorrelation is negative. These values collectively reflect the spatial structure and interdependence among the different regions. So, the different values reflect the link and spatial structure between the different regions.

The Moran index for GDP is presented as follows:

$$I = \frac{n}{\sum_{i=1}^{n} \sum_{j=1}^{n} (w_{ij})} \frac{\sum_{i=1}^{n} (w_{ij} (GDPi - \overline{GDP})(GDP\ j - \overline{GDP}))}{\sum_{i=1}^{n} ((GDP_i - \overline{GDP}))} \tag{6}$$

w_{ij} : is a matrix of spatial weights of unit i and j. n: is the total number of regions.

4.3 Specification and estimation techniques

The choice of variables for the econometric study in this section is inspired by several works, notably (Kim et al., 2018b). (King & Levine, 1993b, 1993c), incorporating the financial inclusion index as an explanatory variable alongside other variables reflecting endogenous growth theory. The model also includes control variables and is based on the Cobb-Douglas function, presented in the following form:

$$Y_{it} = T_{it}^{1-\beta} K_{it}^{\beta} L_{it}^{1-\beta} \quad (7)$$

By integrating capital per capita instead of total capital, 0<β<1, the Cobb-Douglas function becomes (Wu & Gu, 2019) :

$$y_{it} = t_{it}^{1-\beta} k_{it}^{\beta} \quad (8)$$

The panel structure of our model, after transformation of the Cobb-Douglas function, is presented as follows:

$$lnyit = \beta_0 + \beta_1 lnt_{it} + \beta_2 lnk_{it} + \varepsilon_{it} \ (9)$$

From equation (9), it is possible to estimate the effects of financial inclusion on economic growth. Before incorporating the data into the spatial model, it is important to determine the approach adopted for selecting the appropriate model. Several methods exist for estimating spatial models, including the general-to-specific approach, the specific-to-general approach, and the (Elhorst, 2010) approach, which combines both and proposes an OLS based estimation strategy to test between the spatial lag model and the spatial error model.

The SAR model combines the conventional OLS regression model with the spatially shifted dependent term. The spatial extension of the standard regression defined by equation (10):

$$y_{it} = \alpha \sum_{j=1}^{N} w_{ij} y_{jt} + \beta x_{it} + \mu_i + \varepsilon_{it} + \eta_t (10)$$

The spatial error model (SEM) is presented as follows:

$$y_{it} = \beta x_{it} + \mu_i + \eta_t + u_{it} \quad (11)$$

$$u_{it} = \lambda \sum_{j=1}^{N} w_{ij} u_{jt} + \varepsilon_{it} \ (12)$$

For both models, variables are double-indexed: the first index “i” characterises the region under consideration, and the second index “t” characterises the observation period. $\boldsymbol{y_{it}}$ represents the variable to be explained, $\boldsymbol{x_{it}}$: represents the explanatory variables, $\sum_{j=1}^{N} w_{ij} y_{jt}$ denotes the spatial lag term, $\boldsymbol{\alpha}$ is the spatial autoregressive coefficient, $\boldsymbol{w_{ij}}$ is the spatial matrix of dimension NxN, β is a parameter of the explanatory variables to be estimated, $\boldsymbol{\eta_t}$ denotes the temporal effect, $\boldsymbol{\mu_i}$ represents the specific spatial effect, $\boldsymbol{\varepsilon_{it}}$ is the error term.

The SDM model simultaneously incorporates the spatial lag of the dependent variable and the spatial lags of the explanatory variables, thereby capturing the significance of the impact of spatial autocorrelation.

$$y_{it} = \alpha \sum_{j=1}^{N} w_{ij} y_{jt} + \gamma \sum_{j=1}^{N} w_{ij} x_{jt} + \beta x_{it} + \mu_i + \varepsilon_{it} + \eta_t \ (13)$$

$\gamma \sum_{j=1}^{N} w_{ij} x_{jt}$: spillover effects from exogenous variables in neighbouring regions.

The spatial Durbin dynamic panel model incorporates the time lag of the dependent variable, as well as spatiotemporal and instantaneous lags.(Lee & Yu, 2010) use maximum likelihood estimation (MLE) to discuss the differences between static and spatial dynamic methods. The incorporation of the spatial Durbin dynamic model better addresses endogeneity issues in the model (Espoir & Sunge, 2021).

$$y_{it} = \varphi y_{it-1} + \alpha \sum_{j=1}^{N} w_{ij} y_{jt} + \gamma \sum_{j=1}^{N} w_{ij} x_{jt} + \beta x_{it} + \mu_i + \varepsilon_{it} + \eta_t \quad (14)$$

φy_{it-1}: Represents the Time Inertia effect.

5 Results

There are two steps to determining the appropriate spatial model. First, spatial dependence must be detected. Second, the non-spatial model, the spatial lag model, and the spatial error model are estimated (Anselin, 1988). Least squares estimation following the detection of spatial autocorrelation may affect the validity of the estimated parameters. Therefore, maximum likelihood estimation (MLE) is a more appropriate method for solving the endogeneity problem.

5.1 Spatial autocorrelation: Moran's index

The annual Moran's I statistic for the GDP and IFI variables is based on the Queen contiguity matrix, used to capture the economic and financial inclusion interactions between two regions.

The annual Moran's I test is significant at the 5% level for the IFI and the DGP (the test is provided in appendix 6). This indicates that a region's financial inclusion has spatial effects on the level of financial inclusion in another region (neighbourhood effects); in particular, in 2020, the Moran's I index shows weak spatial autocorrelation. The spatial distribution of GDP values indicates the existence of a spatial effect across different years. Most of them exhibit positive spatial autocorrelation, with a decline between 2015 and 2016, followed by slight fluctuations between 2017 and 2021; these findings may depend on exogenous effects influencing spatial correlation, but they suggest that regions with high and low growth tend to be spatially clustered. Similarly, geographic proximity can influence the Kingdom's economic growth.

The results of the spatial autocorrelation test, as measured by Moran's I, confirm the existence of significant annual spatial autocorrelation over the period 2015–2021. The detection of spatial interdependence among Morocco's regions leads to the specification of a spatial model to better identify the relationship between financial inclusion and economic growth and to assess the spatial effects.

5.2 Model and estimation strategy

The process of selecting the appropriate model is based on the specific-to-general approach proposed by (LeSage and Pace, 2009) and (Elhorst, 2014). The Lagrange multiplier (LM) test is considered one of the primary tests used to specify the appropriate model (Elhorst, 2014). The log-likelihood (LR) test was used to test the following two hypotheses: $H0 : \theta = 0$ and $H0 : \theta + \rho\beta = 0$, allowing us to determine whether the SDM can be reduced to SAR or SEM. Following the validation of spatial autocorrelation, the AIC and BIC criteria are used to identify the most appropriate model among the following (Belotti et al., 2017).

The following table 2 summarises the results of the LM test, represented by two LM-Error and LM-Lag tests for choosing between the traditional and spatial approaches.

Table 2. Spatial autocorrelation test of estimated residuals in the linear panel model.

Test	Statistic	df	p-value
Spatial error:			
Moran's I	7.577	1	0.000
Lagrange multiplier	46.250	1	0.000
Robust Lagrange multiplier	31.492	1	0.000
Spatial lag:			
Lagrange multiplier	15.515	1	0.000
Robust Lagrange multiplier	0.758	1	0.384

Source: Compiled by the author from estimates with Stata 17.

The results show that the Queen contiguity matrix produces significant LM-error tests, the Moran, and LM-lag tests, confirming the existence of spatial autocorrelation and suggesting that OLS parameter estimates may be biased. This finding may lead to misleading conclusions.

Table 3. Estimation results for the OLS, SEM, SAR, SDM and DSDM.

	SDM	DSDM	SAR	SEM	OLS FE
	LDGP	LDGP	LDGP	LDGP	LDGP
main					
IFI	0.138**	0.120**	0.157**	0.154***	0.157**
	(0.0626)	(0.0537)	(0.0634)	(0.0571)	(0.0723)
UR	0.00182	-0.00147	0.00509	0.00796*	0.00384
	(0.00376)	(0.00430)	(0.00408)	(0.00419)	(0.00444)
HCI	0.0564***	0.00659	0.0185	0.0105	0.0208
	(0.0181)	(0.0252)	(0.0128)	(0.0104)	(0.0143)
HFCE	0.328	0.0575	0.0319	-0.0392	0.0418
	(0.237)	(0.255)	(0.127)	(0.114)	(0.145)
AR	0.00478**	0.000720	0.00733***	0.00820***	0.00709***
	(0.00191)	(0.00191)	(0.00210)	(0.00204)	(0.00238)
dami_v	0.0390***	0.0353***	0.0367***	0.0341***	0.0362***
	(0.0133)	(0.0118)	(0.0115)	(0.0104)	(0.0131)
LDGP(t-1)		0.532***			
		(0.0970)			
Constant					-0.0382
					(0.460)
Wx					
IFI	0.0464	0.000865			
	(0.0924)	(0.0797)			
UR	0.0228***	0.0211**			
	(0.00761)	(0.00983)			

HCI	-0.0549**	-0.124**			
	(0.0216)	(0.0578)			
HFCE	-0.649**	-0.296			
	(0.275)	(0.371)			
AR	0.0115**	0.0152***			
	(0.00486)	(0.00462)			
Spatial					
rho	-0.441**	-0.434**	-0.205		
	(0.204)	(0.213)	(0.198)		
lambda				-0.442*	
				(0.235)	
Variance					
sigma2_e	0.000349***	0.000243***	0.000472***	0.000447***	
	(0.0000552)	(0.0000414)	(0.0000731)	(0.0000712)	
AIC	-401.048	-364.1846	-388.3265	-390.334	-389.2446
BIC	-369.4474	-332.3112	-368.88	-370.8874	-372.2289
Log-likelihood	213.524	196.0923	202.1633	203.167	201.6223
Observations	84	72	84	84	84

Source: Compiled by the author from estimates with Stata 17.

Table 4. Results of the LR test

Likelihood-ratio test	LR chi2(5)	Prob > chi2
Assumption: SAR nested within SDM	22.72	0.0000
Assumption: SEM nested within SDM	20.71	0.0000

Source: Compiled by the author from estimates with Stata 17.

The test results shown in Table 2 confirm the existence of spatial autocorrelation and indicate, based on the Queen contiguity matrix, that the SAR and SEM models can be adopted.

Table 3 presents the results of the OLS, SEM, SAR, SDM and DSDM models; The Akaike Information Criterion (AIC) and Bayes Information Criterion (BIC) et log-likelihood values, which allow us to compare the quality of fit of these models. The higher AIC value of the OLS model, combined with the detected spatial autocorrelation, confirms its inadequacy in this context.

The SEM, SAR, SDM, and DSDM models all indicate a positive coefficient for financial inclusion. The DSDM model incorporates a time lag of economic growth, yielding a significant positive value, which reflects inertia in in economic growth dynamics, while financial inclusion retains a positive sign. The estimated coefficient values for financial inclusion and spatial lag in both the SDM and DSDM models are statistically significant and consistent in sign. The spatial dependence coefficient in the SDM (Rho = -0.441($p<0.05$)) is lower than that in the DSDM. The LR tests (lag and error) reject the null hypotheses, confirming that the SDM cannot be simplified to SEM or SAR. The SDM's AIC = -401.048 and log-likelihood (Log-L = 213.524) values support goodness of fit of the model. These findings confirm the SDM's capacity to better capture the relationship between financial inclusion and economic growth.

The SDM model revealed a negative spatial dependence coefficient ($\rho = -0.441$, $p < 0.05$). This result indicates a negative spatial dependence between local economic growth and that of neighbouring regions; this can be explained by the fact that economic growth in geographically contiguous regions can hinder growth in other regions. This finding thus reflects the concentration of wealth in certain regions at the expense of others.

On average, these results are consistent with those of (Lucas, 1988; Romer, 1986). The estimated coefficient of financial inclusion (0.138, $p < 0.05$) is positively associated with economic growth, supporting the positive relationship between the two factors. However, the urbanisation rate has a positive but insignificant effect ($p > 0.05$), as does HFCE, which also has a positive but non-significant value; this suggests that these relationships are not robust. The level of education, reflecting human capital, shows a positive and statistically significant correlation of 0.0564 ($p < 0.01$), with economic growth productivity (Schultz, 1961).

The spatial lag coefficient for the IFI (WxIFI) is not statistically significant, which requires further clarification and analysis. The spatial lags of the urbanisation rate and the labour force participation rate show positive effects. Indeed, an increase in the labour force participation rate and/or the urbanisation rate in neighbouring regions has a positive effect on local economic growth. The spatial lag of the level of human capital shows a negative effect; This correlation indicates that an increase in human capital may have negative externalities on economic growth, despite economic growth in neighbouring regions.

The coefficients of the explanatory variables do not represent the true effect of the regression, which limits the integration (presentation) of the spatial effects of the explanatory variables on those explained. To remedy this efficiency problem,(LeSage & Pace, 2009) introduced a more efficient fundamental aspect based on the analysis of the direct and indirect effects of the explanatory variables on the variable to be explained. The direct effect represents the effect of the explanatory variables in one region on the variable to be explained in that same region; the indirect effect, by contrast, represents the average effect of the explanatory variables on the variable to be explained across all other regions.

After selecting the SDM model with individual fixed effects, in accordance with (LeSage & Pace, 2009) and (Elhorst, 2014) the final step involves estimating the direct and indirect effects of the explanatory variables, which allows us to obtain a meaningful and detailed interpretation of the spatial spillover effects in the model

Table 5. The spillover effect.

	LR_Direct	LR_Indirect	LR_Total
IFI	0.141**	-0.00705	0.134**
	(0.0704)	(0.0703)	(0.0565)
UR	-0.000100	0.0147***	0.0146**
	(0.00375)	(0.00562)	(0.00570)
HCI	0.0654***	-0.0540***	0.0114
	(0.0194)	(0.0184)	(0.0104)
HFCE	0.395	-0.527**	-0.132
	(0.260)	(0.228)	(0.149)

AR	0.00397**	0.00662**	0.0106***
	(0.00198)	(0.00335)	(0.00309)
dami_v	0.0417***	-0.0116	0.0302***
	(0.0142)	(0.00711)	(0.0103)

Source: Compiled by the author from estimates with Stata 14.

The average relationship between financial inclusion and economic growth is positive, reflecting the fact that expanding financial inclusion can have an impact on economic growth in each region (table 4). Table 5 shows that for direct effects, the level of financial inclusion is significant at the 5% level, indicating that a 0.141 percentage point increase in financial inclusion in a region leads to economic growth in that same region. The indirect effects, however, are not significant. The total effects, which encompass both direct and indirect effects, confirm this interpretation, with financial inclusion showing a positive and significant effect. This dual significance reinforces strong positive relationship between regional financial inclusion and economic growth (Kim et al., 2018b) and (Ezzahid & Elouaourti, 2021). In addition, these findings suggest that, at the regional level, improved financial inclusion can lead to increase access to and utilisation of financial services, thereby creating opportunities for investment and savings (Levine, 2005).

The labour force participation rate has significant positive direct and indirect effects, indicating that an increase in the labour force participation rate impacts both local and neighbouring regions' economic growth; the combined total effect is also positive (Liu et al., 2024). The level of human capital shows a significant positive direct effect and a significant negative indirect effect; the positive direct effect indicates that human capital in a region is a key driver of local economic growth (Lucas 1988; Romer 1989) ; the negative indirect effect suggests that improvements in human capital in a region would reduce the level of economic growth in neighbouring regions; these findings may reflect the persistence of regional inequalities characterised by the concentration of industry and offshoring zones in northern regions, and interregional migration of skilled workers toward highly skilled and more attractive jobs (Olejnik, 2008).

The level of consumption shows only a significant negative indirect effect with a high coefficient (-0.527, $p< 0.05$). This result indicates that an increase in the level of consumption in one region would reduce the level of economic growth in neighbouring regions; these findings may be the result of the implications of GDP concentration in certain regions. The urbanisation rate, with a coefficient of (0.0147, $p<0.01$) for indirect effects, had a positive impact on economic growth in neighbouring regions (Wu & Gu, 2019). These findings regarding consumption and urbanisation are consistent with previous research by (Fischer et al., 2009).

Encouraging financial inclusion equally can not only increase the rate of economic growth, but also help to develop the structure and sphere of financial, which will have a positive impact on the financial resources of the entire population (McKinnon, 1993) and (Gurley & Shaw, 1955).

5.3 Robustness and endogeneity tests

5.3.1 Robustness tests

The choice of weighting matrix is of critical importance in spatial analysis, as it can influence the results (LeSage & Pace, 2009). This study employs a Queen contiguity matrix. To ensure robustness, the SDM model is re-estimated using the distance matrix and with the exclusion of one year. The results of the re-estimated SDM models remain consistent with the baseline. Appendix 7 presents the results of the robustness tests.

The results of the re-estimated SDM model, using the spatial distance matrix and the exclusion of one year, show no significant changes. The re-estimated SDM model based on two distance matrices and the Queen contiguity matrix shows that the spatial coefficients ρ are significant at the 1% level for both matrices. The financial inclusion index, the labour force participation rate, and the education level retain the same sign as in the baseline model. The results estimated based on the exclusion of the year 2015 show the same sign for financial inclusion and the spatial coefficient. These results confirm the robustness of the baseline model results.

5.3.2 Endogenous test

After comparing the two estimated SDM models based on the financial inclusion index (baseline) and the alternative financial inclusion index, we introduced first-order lag terms for the financial inclusion index (Zhou and Xu, 2022).

Table 6. Estimated Coefficients of the SDM using IFI_{t-1} and alternative IFI.

	LR_Direct		LR_Indirect		LR_Total	
	SDM_IFI_{t-1}	SDM_Baseline	SDM_IFI_{t-1}	SDM_Baseline	SDM_IFI_{t-1}	SDM_Baseline
IFI	0.196**	0.141**	-0.0967	-0.00705	0.0997**	0.134**
	(0.0849)	(0.0704)	(0.0789)	(0.0703)	(0.0433)	(0.0565)
	SDM_IFI_alt_{t-1}	SDM_Baseline	SDM_IFI_alt_{t-1}	SDM_Baseline	SDM_IFI_alt_{t-1}	SDM_Baseline
IFI_alt	0.215**	0.150**	-0.102	-0.00819	0.112**	0.141**
	(0.0896)	(0.0742)	(0.0836)	(0.0745)	(0.0469)	(0.0599)
Observations	72	84	72	84	72	84

Source: Compiled by the author from estimates with Stata 14.

The results for the direct, indirect, and total effects of the SDM models, re-estimated using the methodological approach of (Zhou and Xu, 2022) show the same level of significance for both lagged financial inclusion indices.

6 Conclusion and discussion

While the relationship between financial inclusion and economic growth has been extensively documented in the empirical literature, often revealing a unidirectional or bidirectional causal link, the application of spatial econometrics remains limited. Neglecting these spatial effects in classical models can lead to omitted variable bias and model misspecification. By leveraging spatial econometric analysis, this study moves beyond the traditional isolated look at financial inclusion and economic growth. Instead, it explicitly addresses the spatial disparities among

Moroccan regions and captures spatial spillover effects. Specifically, our study is based on the SDM model.

The SDM and dynamic SDM models retain the same significant sign for financial inclusion, though the DSDM model shows that economic growth exhibits significant time lags and negative dependence. The estimates of SDM model, using two approaches: the first based on estimating the SDM model with the Queen's neighbourhood matrix and the distance matrix, and the second involving the removal of one year. Both approaches demonstrate that financial inclusion maintains a positive relationship with economic growth.

Over time, the presentation of IFI reveals the significant concentration of wealth in three regions, highlighting the existence of spatial disparities among Morocco's regions in terms of wealth creation and financial inclusion. Furthermore, the results of our spatiotemporal study reveal the existence of spatial autocorrelation in the Moroccan regional economy. The Moran's Index for financial inclusion is positive and significant, indicating spatial clustering of financial inclusion.

The results of the SDM model show Rho (ρ) is negative and statistically significant. This signifies that economic growth in one region appears to generate modest growth in neighbouring regions. Furthermore, the variables included in the model have both direct and indirect effects, which supports the existence of spillover effects.

Financial inclusion has significant positive direct effects on local economic growth, but it doesn't have a significant effect in neighbouring regions, although overall, financial inclusion is positively correlated across regions. These findings can be interpreted as the result of weak interconnections between regions, the spatial and socioeconomic characteristics of each region, revealing a two-speed Morocco.

The integrated factors show that the labour force participation rate has positive and significant local and neighbouring regions effects with economic growth, which can be explained by the attractiveness of the labour market and the mobilisation of the workforce. The urbanisation rate is strongly associated with economic growth at both neighbouring regions. The level of human capital exhibits a positive direct local effect, which is consistent with most previous studies; however, the indirect effects are negative, which can be explained primarily by the dynamics of labour migration flows (Zhu et al., 2011).

The positive link between financial inclusion and economic growth, confirmed in this study, represents an empirical contribution to the theoretical literature. The spatial model adopted confirms the theoretical foundations, supporting the relationship between financial inclusion and economic growth.

In light of these findings, which are reinforced by the spatial approach, there is evidence of a positive association between economic growth and financial inclusion. Furthermore, the negative spatial relationship revealed by the coefficient of the global spatial autoregressive effect confirms the existence of spatial disparities. These findings suggest the importance of strengthening the financial infrastructure tailored to the characteristics of each region, particularly those with low levels of financial inclusion, and of encouraging initiatives aimed at establishing development links between regions in order to promote spatial justice and strengthen regional interconnectivity.

Limitations and recommendations for future research

Like other studies, this study has certain limitations. The small sample size (12×7) limits the use of certain tests, particularly causality tests (Granger causality tests), as well as the inclusion of other variables (due to the risk of overestimation). Furthermore, additional studies could be conducted to better understand the link between financial inclusion and economic growth by focusing on factors that drive growth and financial inclusion and reduce spatiotemporal economic disparities; for example, the role of the digital sector (infrastructure and innovation) and women's participation in the economy. In conclusion, the relationship between financial inclusion and economic growth warrants further exploration.

Appendix :

Appendix 1. Weighting of sub-indicators

Indicator (i)	Indicator weight (Wi) %
ATMs	93,773
LOANS	4,399
DEPOTS	1,632
BRANCHES	,196

Appendix 2. Correlation matrix of sub-indicators.

ATMs	**1.0000**			
LOANS	0.8499*	1.0000		
	0.0000			
DEPOSITS	0.9576*	0.9438*	1.0000	
	0.0000	0.0000		
BRANCHES	0.9347*	0.8539*	0.9589*	1.0000
	0.0000	0.0000	0.0000	

Appendix 3. Autocorrelation Test Between IFI and Alternative IFI.

	IFI_alt	IFI
IFI_alt	1.0000	
IFI	0.9999* 0.0000	1.0000

Appendix 4. VIF test

Variable	VIF	1/VIF
AR	4.81	0.207954
IFI	3.89	0.257227
UR	3.52	0.284094
HFCE	2.91	0.343159
HCI	1.97	0.507423
dami_v	1.11	0.899251
Mean VIF	**3.04**	

Appendix 5. Correlation table.

	LDGP	FIACPD26	UR	HCI	HFCE	AR	dami_v
LDGP	1.0000						
FIACPD26	0.8583*	1.0000					
	0.0000						
UR	-0.1448	0.1067	1.0000				
	0.1887	0.3340					
HCI	0.0338	-0.2184*	-0.6377*	1.0000			
	0.7599	0.0459	0.0000				
HFCE	0.0357	0.2575*	0.7496*	-0.4823*	1.0000		
	0.7474	0.0181	0.0000	0.0000			
AR	0.8450*	0.5863*	-0.5539*	0.3660*	-0.4124*	1.0000	
	0.0000	0.0000	0.0000	0.0006	0.0001		

dami_v	0.0113	-0.1758	0.0295	0.1310	0.0403	-0.0341	1.0000
	0.9186	0.1098	0.7902	0.2350	0.7160	0.7581	

Appendix 6. The results of the overall Moran index of the level of economic growth (GDP) and the level of the financial inclusion index

Year	GDP_R	P-value	IFI	P-value
2015	0.569	0.002	0.276	0.03
2016	0.269	0.02	0.268	0.03
2017	0.271	0.02	0.268	0.03
2018	0.255	0.02	0.267	0.03
2019	0.261	0.02	0.269	0.03
2020	0.242	0.03	0.05	0.049
2021	0.255	0.02	0.260	0.03

Source: Compiled by the author from estimates with GeoDa.

Appendix 7. Estimated Coefficients of the SDM using different spatial weight matrices.

	SDM_ Distance		**SDM_Weight**		**SDM_(t-1)**	
	LDGP					
	Main	Wx	Main	Wx	Main	Wx
IFI	0.129**	0.0858	0.138**	0.0464	0.107*	0.0495
	(0.0530)	(0.0938)	(0.0626)	(0.0924)	(0.0633)	(0.0930)
UR	0.00595	0.0182***	0.00182	0.0228***	-0.000984	0.0395***
	(0.00380)	(0.00555)	(0.00376)	(0.00761)	(0.00507)	(0.0109)
HCI	0.0426**	-0.0231	0.0564***	-0.0549**	-0.00467	-0.177***
	(0.0195)	(0.0227)	(0.0181)	(0.0216)	(0.0295)	(0.0673)
HFCE	-0.0718	-0.130	0.328	-0.649**	0.634**	-1.272***
	(0.468)	(0.490)	(0.237)	(0.275)	(0.272)	(0.380)
AR	0.00698***	0.0182***	0.00478**	0.0115**	0.00354	0.0153***
	(0.00187)	(0.00424)	(0.00191)	(0.00486)	(0.00217)	(0.00545)
dami_v	0.0542***		0.0390***		0.0343**	
	(0.0171)		(0.0133)		(0.0139)	
Spatial						
rho	-0.388***		-0.441**		-0.563**	
	(0.128)		(0.204)		(0.222)	
Variance						
sigma2_e	0.000297***		0.000349***		0.000341***	
	(0.0000464)		(0.0000552)		(0.0000591)	
Observations	**84**		**84**		**72**	

Source: Compiled by the author from estimates with Stata 14.

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