Hindawi
Advances in Multimedia
Volume 2023, Article ID 5167499, 12 pages
https://doi.org/10.1155/2023/5167499

Research Article

Evaluation of Spatial Spillover Effect of Multidimensional Hybrid Financial Risk Contagion Based on the DAI Spatial Econometric Model

Shanshen Li and Zhonghui Dong

School of Economics and Management, Xi'an Shiyou University, Xi'an 710065, Shaanxi, China

Correspondence should be addressed to Shanshen Li; ssli@xsyu.edu.cn

Received 21 October 2022; Revised 26 December 2022; Accepted 22 March 2023; Published 3 April 2023

Academic Editor: Mansaf Alam

The process of global integration has accelerated, and the international financial market has become increasingly closely linked. The financial risks that come with them are becoming more complex and difficult to guard against. Multimedia modeling in Health Cloud biometric authentication and data management systems can be applied to the analysis of financial markets. Most of the current financial risk analysis models are based on a single time, and the models are relatively simple and cannot adapt to the current complex multidimensional mixed financial risk environment. Therefore, this paper aimed to analyze the spatial spillover effect of financial risk contagion based on the directed asymmetric (DAI) spatial econometric model. This paper proposed to transfer entropy information weight information and introduce the GARCH (generalized auto-regressive conditional heteroskedasticity) model to improve the traditional econometric model. By constructing a DAI measurement model, the spatial contagion of multidimensional mixed financial risks was analyzed, and on this basis, a generalized multidimensional economic space was established to analyze spatial spillover effects and analyze the specific path of spatial spillover effects. The model results in this paper showed that the degree of correlation between the stock and bond market varied greatly between countries. Among them, the change coefficient $W_{s \longrightarrow b} r_s D$ of the event period was judged to have a large degree of negative change in the United Kingdom, Germany, and France in the European Union, which were −0.9885, −0.9876, and −0.9748, respectively. This showed that the model in this paper had a good and reliable ability to cope with the current multidimensional mixed complex financial risk environment and could be used as a reference for financial risk-related research. At the same time, it also proved that multimedia modeling in health cloud biometric authentication and data management system could provide a role in financial risk contagion analysis.

1. Introduction

Financial risk contagion refers to the interconnection of the quantity or quality of financial activities or financial assets (including financial instruments) in financial markets so that the financial asset portfolio of other countries is covered by various financial consequences, which is one of the important phenomena in global financial markets. The development of economic globalization has led to the flow of a large number of resources such as capital, talents, and information to the world, so the strengthening of economic ties between different countries has led to the intersection of various financial activities, which has formed a close connection between diversified and mixed cross-border financial capital markets and global financial markets. In the context of global economic integration and with the increasing number of cross-border investment and cross-border business activities, the economic ties between countries and regions around the world have become closer. Financial assets and instruments intertwined between different countries form diversified financial products and systems, which makes the interaction between various assets in the region more complex and generates many unstable factors. Therefore, when countries carry out various forms and different nature of capital financing, investment and financing activities across borders, financial risks are prone to occur, which would have a significant impact on the local economy.

Research on risk contagion and investment diversion has yielded many results. Wang et al. analyzed the yields of the U.S. stock and bond markets from 1929 to 2001. His findings suggested that there was a significant positive correlation overall, but some subsample periods have shown negative correlations [1]. Sacks et al. analyzed the relationship between stock and bond markets in the world's eighth largest economies. His findings suggested that investment diversion is a widespread phenomenon in different economies and is intrinsically linked to the spread of risk [2]. Payzan-LeNestour and Woodford used spatial econometrics to empirically analyze the relationship between equity and bond markets before, during, and late U.S. financial risk, which confirmed the safe transfer of investors from securities to bond markets during crises [3]. Through the summary of relevant research, it can be found that it is not enough to rely on theoretical analysis to study financial risks. Evaluation and analysis through the establishment of models can make up for many shortcomings of pure theoretical analysis, and the results of analysis are more oriented.

With the development of statistical economics and other disciplines, there are many theoretical and practical studies on financial risk models. Bucciol and Miniaci analyzed the decline in almost all stock markets during October 1987, although economic conditions varied greatly from country to country, and used models to empirically study the interaction of stock markets in different countries [4]. Zhong investigated the impact of sovereign risks in the Eurozone between 2008 and 2012. The results showed that long-term government bond yields across Eurozone countries have significantly interacted during this period, and the market's willingness to risk has been found to be the main factor affecting sovereign risk [5]. Pekar and Pcolar built an analytical model of an arbitrarily structured financial network and empirically studied it. His findings suggested that the financial system is a stable and fragile system whose contagion effect would be very common with less risk [6]. However, the research on financial risk of related models still pays too much attention to the impact of a single time, and lacks the discussion of spatial models.

The study of the contagion model of financial risk has strong practical significance. Specifically, this paper first analyzed the current financial risk environment and explained the significance of this research. After that, the DAI measurement model was established and analyzed in detail, and the risk contagion situation at the time of Brexit in 2016 was empirically analyzed. Finally, the generalized multidimensional economic space was used to analyze the spillover effect and path of financial risk contagion.

2. Related Methods of Financial Risk Assessment

2.1. Multimedia Modeling in Health Cloud Biometric Authentication and Data Management System. Since the 80s of the 20th century, various economic and financial events have occurred one after another. Among them, the US subprime mortgage crisis, the downgrade of Europe's sovereign credit rating, the European debt crisis, and the three major black swan events in 2016 have all caused unpredictable variables in the world economy, which has made international financial data appear new characteristics, that is, asymmetric information transmission, directed information spillover, and other characteristics. This has also brought scholars, investors, and economic leaders from all over the world to pay renewed attention to the transmission channels and mechanisms of financial risks. In view of the shortcomings of traditional econometric methods, the spatial weight matrix can be set in spatial measurement economics, and the transfer entropy can be used to construct the DAI economic information space from the perspective of directed information flow. This can make it better adapt to the real characteristics of the financial market economy and better capture the nonlinear information between markets [7]. This paper used the DAI economic information space to analyze the spillover effect of financial risk space between the first-order and second-order moments of the financial market. By using the composite network theory, a high-level information space econometric model was established, and the propagation path and spatial impact of financial risks were analyzed. Spatial econometrics can be regarded as a synthesis of the following three major theories: spatial economy, spatial statistics, and mathematics, and their composition are shown in Figure 1. In the past 40 years, China's space measurement theory has developed rapidly and has been further developed and improved. Moreover, it is gradually valued and applied by scholars in other fields. However, the study of spatial econometrics in China is still in its infancy. The economic development of various regions in China is very different, and the scale of economic development and economic structure are regional, which has caused difficulties for the study of spatial econometrics.

2.2. Financial Risks. In order to effectively reduce the risk in financial risk, investors usually hold a variety of assets. During periods of financial risk, if the gains from diversification of assets such as stocks and bonds are not significant, it is considered to be a contagion of cross-market risk. When some assets rise abnormally during periods of financial risk, such as abnormal volatility in the stock and bond markets, it is usually considered to have been a cross-market investment shift. It is because of this "investment transfer" that investors can reduce their financial losses by holding stock securities and bonds; thus, allowing them to earn positive returns. Cross-market risk diffusion and investment transfer between markets are known as "cross-market effects." The economic linkages between nations (regions and cities) have gotten closer with the expansion of global economic integration and financial liberalization. The process of international integration and the simple diversification of international transactions have deepened the impact of financial risks, which is shown in Figure 2 [8].

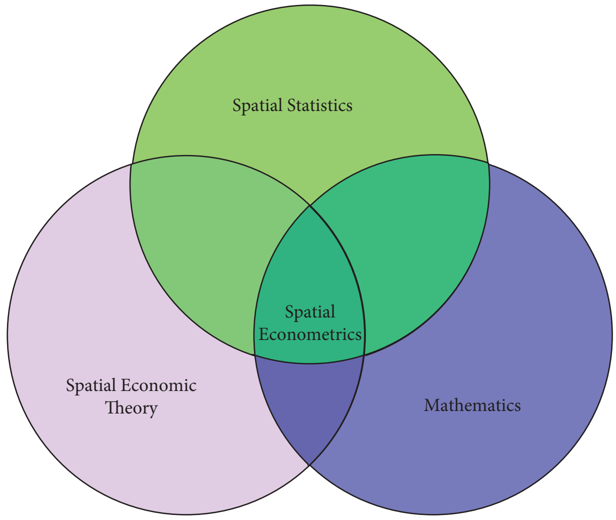

Figure 1: Spatial econometric compositions.

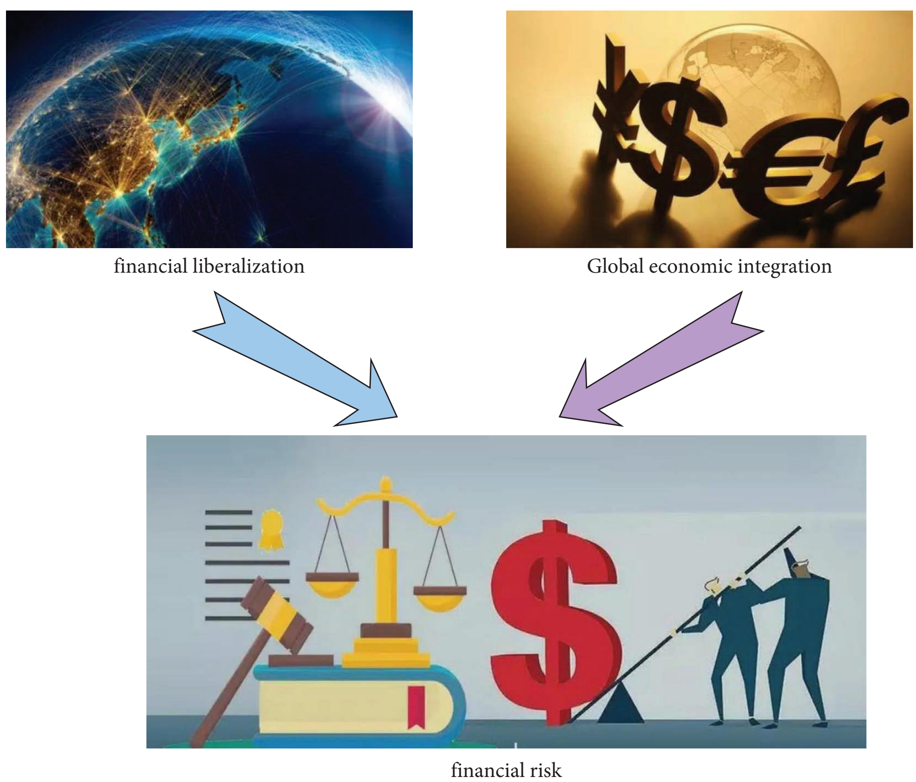

Figure 2: Financial risks.

A domino effect occurs when an economy experiences an economic crisis or sudden event. This can ripple through neighboring countries or economies with close trade ties and can lead to risk diffusion or investment diversion, which can lead to market turmoil and even global economic volatility. In particular, after the 80s, financial risks around the world have become more frequent, such as the Latin American debt crisis in the 80s and the Mexican financial risk in 1994, all of which have caused violent turmoil around the world. As such, financial risk research is an important theoretical guide for both investors and policy makers in China. 2016 is the "Year of the Black Swan" in the UK. From June 23, 2016, a referendum on leaving the European Union ended in the form of "Brexit." This was the first black swan event in European and world financial markets. The election of the 45th president of the United States was the second black swan event for the global economy in 2016. Italy amended its constitution on December 4, and it was the same day that the Italian Prime Minister resigned [9].

3. DAI Measurement Model and Effectiveness Test of Financial Risk Contagion

This paper combined information theory with traditional GARCH models. By using the method of transferring entropy, the information influence weight value between two economic units was introduced into the traditional GARCH model, and a DAI-based measurement model was established. This paper examined the nonlinear flow of information between nine major economies in the context of Brexit and examined its correlation during periods of financial risk. Specifically, this paper took the first "black swan" event in the UK as the background and empirically analyzed the impact of the traditional GARCH model on the securities market and analyzed the impact of Brexit. It includes nine major economies in the world, including the United States, Japan, Germany, France, the United Kingdom, Italy, China, Australia, and Canada.

3.1. Construction of DAI Measurement Model

3.1.1. Risk Contagion and Investment Transfer. Cross-market effects are generally seen as cross-market investments and the spread of cross-market risks due to market risks. From an asset perspective, risk contagion between markets and investment transfer between markets are mutually exclusive. When there is cross-risk between two different financial assets, there would be no investment transfer. Internationally, the two can coexist. If the risk in the stock market of various countries spreads and causes the stock market to fall at the same time, then it is possible to divert the investment of the stock market in the bond market to other countries. If investment shifts from the bond market to the stock market, risk diffusion is likely to occur in the bond markets of different countries, and the spread of risk and the transfer of investment would promote or weaken each other. Risk contagion increases (weakens) the pass-through of investments, and the diversion of investments increases (decreases) risks [10, 11]. In order to describe cross-market risk contagion and investment transfer, this article used the stock market and bond market as examples. In Figure 3, the definition is displayed.

3.1.2. Time-Varying Symbolized GARCH Model. Due to the complexity of the financial system, economic crises, emergencies, black swan events, etc., can lead to system instability, which would lead to changes in the interaction between systems, this change is bound to affect the correlation between markets to some extent. Therefore, the effective grasp of changes in the interaction between various systems is more objective and reasonable for evaluating the correlation between various markets. From this perspective, this paper proposed a method based on passing entropy. It captures the interactions between nonlinear systems with asymmetry and reduces them to the statistical correlation of the source sequence itself, and transfers the temporal changes between the stock and bond market to the weight of influence established by entropy. In this way, the internal relationship between the stock and bond markets can be dynamically grasped, so as to predict the relationship between the financial markets more accurately and reasonably.

Therefore, on the basis of GARCH model, this paper combined information theory with transfer entropy to establish a time-variable transfer entropy model GARCH based on GARCH (1,1) [12, 13].

$$
\begin{aligned}
\frac{T_{b\longrightarrow s,t}}{T_{b\longrightarrow s,t}+T_{s\longrightarrow b,t}}R_{b,t} &= \alpha+\beta\frac{T_{s\longrightarrow b,t}}{T_{b\longrightarrow s,t}+T_{s\longrightarrow b,t}}R_{s,t} \\
&\quad +\gamma\frac{T_{s\longrightarrow b,t}}{T_{b\longrightarrow s,t}+T_{s\longrightarrow b,t}}R_{s,t}D_{\text{event},t}+\gamma^{*}\frac{T_{s\longrightarrow b,t}}{T_{b\longrightarrow s,t}+T_{s\longrightarrow b,t}}R_{s,t}D^{*}_{\text{event},t}+e_t, \\
e_t \sim N\left(0,\sigma_t^2\right)&, \sigma_t^2=\omega+\lambda e_{t-1}^2+\rho\sigma_{t-1}^2, t=1,2,\cdots,T.
\end{aligned}
\tag{1}
$$

Among them, $T_{b\longrightarrow s,t}, T_{s\longrightarrow b,t}$ represent the transfer entropy from the bond market to the securities market and the securities market to the bond market, respectively. It can be seen from information theory that it reflects the amplitude and direction of nonlinear information transmission between systems. For the traditional time series data processing method, a symbolization algorithm based on dynamic adaptation is proposed to divide the original data, and then the expression of the algorithm is used to find the transfer entropy. Both $D_{\text{event},t}$ and $D^{*}_{\text{event},t}$ are virtual. If t is in an event period, then $D_{\text{event},t}$ is 1, and if not, it takes 0. If t is in the early stages of the event, then $D^{*}_{\text{event},t}$ is 1, and if not, it takes 0 [13, 14]. e_t represents a model error term that conforms to the GARCH (1,1) program. This article used 70 trading days as a sliding window. The dynamic symbolic transfer entropy of the stock market and bond market was analyzed, and the traditional GARCH model was modified by establishing dynamic influence weights. When the value of t is 1, it indicates that the transfer from the bond market to the securities market and from the securities market to the bond market is completed; when the value of t is 0, it indicates that the transfer from the bond market to the securities market and from the securities market to the bond market is not completed.

It is similar to the regular GARCH model, and the most common maximum likelihood estimation method is used

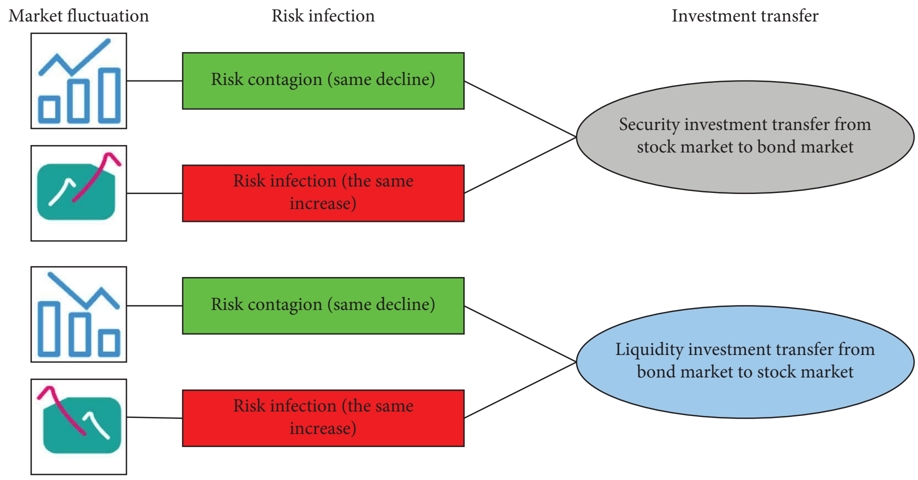

FIGURE 3: Definition of the risk contagion and the investment transfer between stock and bond markets.

and compared to it. It is assumed that the noise term obeys the conditional normal distribution, the corresponding maximum likelihood estimation function for the model is

$$\ln L(\psi) = -\frac{T}{2}\ln(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\ln\sigma_t^2 - \sum_{t=1}^{T}\frac{\left[W_{b\longrightarrow s,t}R_{b,t} - \alpha - W_{s\longrightarrow b,t}\left(\beta R_{b,t} + \gamma R_{b,t}D_{event,t} + \gamma^{*}R_{b,t}D_{\text{event},t}\right)\right]}{2\sigma_t^2}. \tag{2}$$

Among them,

$$W_{b\longrightarrow s,t} = \frac{T_{b\longrightarrow s,t}}{T_{b\longrightarrow s,t} + T_{s\longrightarrow b,t}}, \tag{3}$$

$$W_{s\longrightarrow b,t} = \frac{T_{s\longrightarrow b,t}}{T_{b\longrightarrow s,t} + T_{s\longrightarrow b,t}}, \tag{4}$$

$$\psi = (\alpha, \beta, \gamma, \gamma^{*}, \omega, \lambda, \rho). \tag{5}$$

Formula (5) is a vector with estimated parameters. Previous empirical studies on the causes of financial risk transmission have mostly been classic measurement models, which ignore the connection between crisis countries and only focus on the financial risk transmission state from the "country of origin" to the "infected country," so it can only be analyzed as a one-way linear mechanism. In fact, the transmission of financial risk is a multidimensional network structure, and spatial analysis can fit this situation well. It not only transfers the crisis from the "country of origin" to the "infected country" but also links its connection and impact with the individual countries in crisis [15–17]. The specific financial risk transmission model is shown in Figure 4. Figure 4(a) is the traditional one-way crisis infection model, and Figure 4(b) is the reticular "cross-infection" model.

3.2. Validity Test of DAI Measurement Model

3.2.1. Data Selection and Analysis. This chapter selected bond and stock market data from the world's nine major economies from January 1, 2016, to November 7, 2016, and chose June 23, 2016, to July 23, 2016 as the "black swan" event of Brexit. After excluding the mismatched dates, valid data for 171 trading days can be obtained. The data were obtained from Wand's database. By means of logarithmic first-order difference, the full benefit can be obtained. The calculation formula is

$$R_t = \left(\ln P_t - \ln P_{t-1}\right) \times 100\%. \tag{6}$$

Among them, R_t represents the yield on Tday and P_t, P_{t-1} represent the closing price on Tday and $T-1$, respectively.

Figure 5 shows the descriptive statistical characteristics of the daily yield series of stock markets and government bonds in various countries. From Figure 5(a), it can be seen that among the nine countries, only the United States, the United Kingdom, and Canada had positive returns, and the overall stock market returns were relatively dismal. From Figure 5(b), it can be seen that for government bonds, only Japan had negative returns, and all other countries were positive.

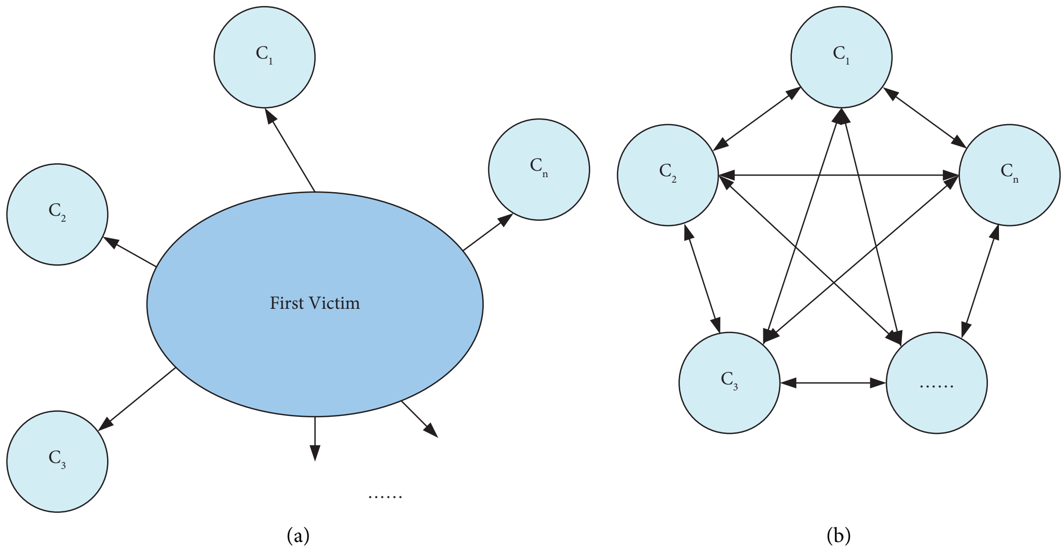

FIGURE 4: Financial risk contagion models: (a) a traditional one-way crisis contagion model; (b) a mesh "cross-infection" model.

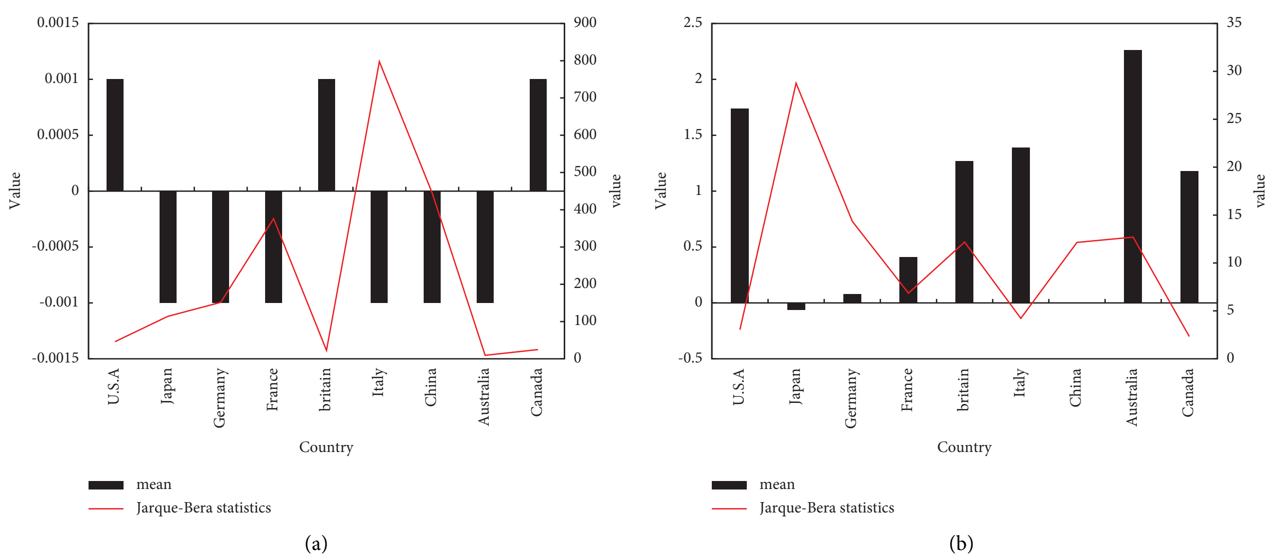

FIGURE 5: Descriptive statistics on the daily yield series of stock markets and government bonds of various countries: (a) stock market yields in various countries; (b) yields of national government bonds.

3.2.2. Empirical Results of GARCH (1,1) Model. This chapter used MATLAB software to perform operations on the model because the method is determined based on the estimated coefficients of the average equation. As a result, only the estimate results of the mean equation were presented in this paper, and the estimation results of the variance formula were not included. The mean equation coefficient estimate results of the GARCH (1,1) model developed in this work are shown in Tables 1 and 2.

Figure 6 shows the results of the comparative analysis of the fitting of the traditional GARCH model and the transferred entropy GARCH (1,1) model. In this paper, the Akaike Information Criterion (AIC) and Schwartz Criterion (SC) of the model were compared with the goodness-of-fit degree R^2 of the model.

By comparing the fitting of the GARCH (1,1) model in Figure 6(a) with the traditional GARCH model in Figure 6(b), it can be found that the R^2 of the GARCH (1,1) model was larger than that of the traditional model, and the AIC and SC values of the GARCH (1,1) model were smaller than the values of the traditional GARCH model.

Data analysis of risk diffusion and investment transfer between various economies were conducted using the concept of cross-market impact and the estimates from the GARCH (1,1) model in Tables 1 and 2. Table 3 presents the outcomes.

The UK is the third largest economy in the world, while London is the world's most important financial center, and "Brexit" has had a great impact on the world economy. From Table 3, it can be seen that under its influence, transactions

Table 1: Estimated results of the mean equation of the GARCH (1,1) model for four countries.

Country	Parameter	$W_{s\longrightarrow b} r_s$	$W_{s\longrightarrow b} r_s D$	$W_{s\longrightarrow b} r_s D^*$	Constant
U.S.A	Coefficient	0.6597	−0.7482	−0.7533	0.2053
	SE	0.0374	0.0179	0.0248	0.0248
	P value	0	0	0	0
Japan	Coefficient	0.463	−0.8441	−0.6737	0.6641
	SE	0.0353	0.0374	0.0152	0.0206
	P value	0	0	0	0
France	Coefficient	0.609	−0.9748	−0.3423	0.3172
	SE	0.056	0.0254	0.0241	0.0378
	P value	0	0	0	0
Italy	Coefficient	0.5313	−0.8002	−0.4308	0.2249
	SE	0.0399	0.0176	0.0164	0.0278
	P value	0	0	0	0

Table 2: Five other countries transfer entropy GARCH (1,1) models mean equation estimation results.

Country	Parameter	$W_{s\longrightarrow b} r_s$	$W_{s\longrightarrow b} r_s D$	$W_{s\longrightarrow b} r_s D^*$	Constant
Canada	Coefficient	0.1131	−0.66	0.21	0.627
	SE	0.0603	0.0552	0.0342	0.0269
	P value	0	0	0	0
Australia	Coefficient	0.3816	−0.5841	−0.422	0.3563
	SE	0.0501	0.0257	0.0179	0.0389
	P value	0	0	0	0
China	Coefficient	−0.0003	0.101	0.0125	0.5434
	SE	0.0751	0.0694	0.0635	0.0231
	P value	0.862	0.113	0.853	0
Germany	Coefficient	0.86	−0.9876	−0.7489	0.2538
	SE	0.0685	0.0511	0.0365	0.034
	P value	0	0	0	0
Britain	Coefficient	0.8453	−0.9885	−0.8604	0.3838
	SE	0.0541	0.0569	0.0408	0.0284
	P value	0	0	0	0

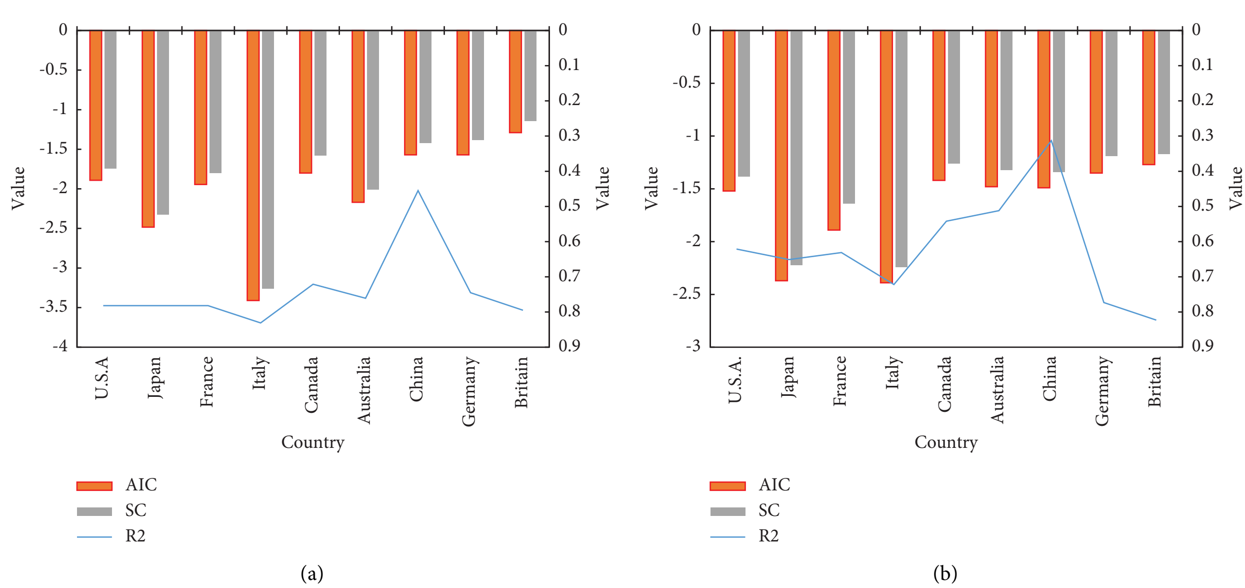

Figure 6: Improve the comparative analysis of models with traditional models: the (a) GARCH (1,1) model; (b) the traditional GARCH model.

Table 3: Statistical results of cross-market effects.

Serial no.	Country	Brexit referendum
1	France	Flight-to-quality
2	Germany	Flight-to-quality
3	Britain	Flight-to-quality
4	U.S.A	Flight-to-quality
5	China	—
6	Australia	Flight-to-quality
7	Canada	Flight-to-quality
8	Japan	Flight-to-quality
9	Italy	Flight-to-quality

between stocks and bonds are common in the securities market. This also showed that in financial risks, the transfer of investment can avoid risk losses to a certain extent and improve the flexibility of the market, thereby maintaining market stability.

Although there has been a safe transfer of investment in countries other than China, an estimate of the change factor $W_{s\longrightarrow b}r_sD$ during the event showed that the degree of correlation change varies between countries. The EU, the United Kingdom, Germany, and France had the largest negative changes at −0.9885, −0.9876, and −0.9748, respectively. The UK is the largest economy in the European Union, with close trade relations with the EU and a high degree of economic integration, which is the backbone of the European economy. The scale of the UK's financial system is huge. London is the world's financial center, and Brexit is bound to have a huge impact on its own and other countries' financial markets. As a result, investors panicked and risk appetite rose, which led to the flow of funds to safe markets such as bonds, and the safe transfer of venture capital occurred. When Britain leaves, it would not only lose its main trading partners but would also assume more economic responsibility. The German economy would also be negatively affected, as would the price of German stocks. Although stock prices have stabilized in all countries after a week, the impact of Brexit has not been completely eliminated, which triggers a domino effect. This could trigger Brexit in other countries, as well as greater instability, which led to investment diversion and risk contagion.

Japan's $W_{s\longrightarrow b}r_sD$ fell by −0.8441, which was higher than Italy's −0.8002. This may be due to Japan's dependence on exports as an important hub for connecting European markets. Brexit would inevitably have an impact on the UK's fiscal position, which would adversely affect Japan's European economy and weaken Japan's financial markets as a result. As a result, investors are more willing to sell their stocks and buy lower-yielding but safer bonds, which make Japan more vulnerable to Brexit in the short term.

For $W_{s\longrightarrow b}r_sD$, Italy was −0.8002, the United States was −0.7482, Canada was −0.66, and Australia was −0.5841. Italy is part of the European Union and is not more affected than other countries, but it also has a considerable degree of security risks. The U.S. stock and bond markets have also seen some movement of money to some extent, but not as much as in European countries. The impact of Brexit on US equities has been relatively small. The United States has a higher position in the EU than the United Kingdom and has an advantage in the global economy. The UK's position in the EU is declining. The two Commonwealth countries of Canada and Australia have suffered negative effects and seen a shift in security risks, but not as severe as in the United States. This may be due to the fact that Brexit has had less impact on the commonwealth members such as the UK, Australia, and Canada.

Brexit uncertainty has had a huge impact on the global economy and finance. Of these factors, the UK has been hit the hardest, while investment in security has also been the hardest. Second, Germany, France, Italy, and Japan, which sees Britain as a link to European markets, have all presented more security risks. The United States, Canada, and Australia have been less affected, but there are some security risks.

This paper used the Brexit referendum as the background to introduce the theory of transfer entropy in information theory to the traditional GARCH model. By using time-varying symbols to shift the weight of entropy influence, the cross-market effect was analyzed. The empirical analysis showed the following:

(1) The DAI measurement model between two economic units was established by the method of transferring entropy, and the model could capture the correlation between them more carefully and accurately, so that the accuracy of the model could be further improved. The results showed that this paper combined with information theory to establish a dynamic intelligent measurement model between two economic units.

(2) Following the Brexit decision, safe investments proliferated across several national stock and bond markets. The results of the study also showed that investment transfer can reduce investors' risk losses to a certain extent, thereby improving market resilience and stability. In short, from an international perspective, the spread of risk and the spread of investment exist at the same time, and may also weaken or even strengthen each other. Therefore, when making investments, the selection of assets should be prudent and the investment should be reasonably optimized to minimize risk losses. At the same time, when formulating economic policies, policymakers must control the situation from a macro level and adopt corresponding. On the other hand, this paper combined information theory with traditional econometric models, but the DAI economic measurement model has shown good results in obtaining financial market information.

3.3. Establishment of Generalized Multidimensional Economic Space and Test of Spatial Spillover Effect. Different regions, different markets, and different industries have led to different dimensions of different financial markets and real economies [18]. This paper analyzed the spatial spillover, aggregation, and evolution of financial risks from a spatial perspective. This paper established a generalized and multidimensional economic space to measure the spatial characteristics of "distance"and "adjacent" and revealed the multidimensional mixed spatial effect of "finance" and "entity." On this basis, the spatial spillover effect of financial risk was studied and its scale was quantified. It is supposed that there are four countries A, B, C, and D, and there is no direct economic relationship between the other two countries except A–D. When A first occurs financial risk at a certain point in time, the two-way risk spillover of AB, AC, BC; a credit crunch would inevitably occur between B and C, and a credit contraction would also occur for D through a two-way spillover of B-D, C-D. In the end, B, C, and D all broke out of financial risks and the outbreak of financial risks was due to the two-way risk spillover of credit subjects and the linkage spillover of credit. The risk spillover relationship of financial risks mentioned above is shown in Figure 7.

An empirical analysis of the spillover effect of financial risk in a broad and multidimensional economic space.

With the deepening of the diversification and multilevel nature of the financial market, the spatial effect of the financial market has been significantly enhanced. The real economy and financial market behavior in the financial market are becoming increasingly complex, and the spatial correlation of economic data has also emerged new characteristics. In the macro- and multidimensional economic space, a macro-measurement model was established to capture the multidimensional spatial effect of financial risk spillover, and in-depth research was carried out. The first thing to consider was the volatility of financial risk. In Figure 8, from top to bottom, the spatial correlation coefficient of the world's nine major financial markets, the cross-industry market spatial dynamic correlation coefficient (industry refers to the world's major political regional economic organizations), and the spatial correlation coefficient of the market itself.

Through Figure 8, it can be found that international financial markets do have multidimensional spatial correlations. Different financial markets are affected by different types of financial market risks, which in turn exacerbate the spillover of spatial risks. Therefore, this paper used spatial econometric theory to explore the risk of financial risk.

3.4. Empirical Analysis of the Spillover Path of Generalized Multidimensional Economic Space of Financial Risk

3.4.1. Data Selection and Analysis. This paper took the Wall Street Journal as the research object to discuss the risk types of European financial risks, which mainly focused on financial markets and the real economy, and studied the correlation between their contagion degree and market openness. In the data settings, Tfree was used as the symbol and calculated on a quarterly basis. Table 4 shows the specific variable explanations.

This paper used the previously established binary space weight matrix and two newly constructed models to empirically analyze the macro multidimensional spatial impact of financial risks. The test method used Moran's I index, LMlag, LMerr, and other methods. On this basis, the spatial correlation was tested, and the selection of spatial delay model (SAR) and spatial error correction model (SEM) were analyzed. The MATLAB program was used to test the adaptability and validity of the gravity space weight matrix and verified it.

In the context of the European debt crisis, the Copula Contagion Index was used as an indicator to measure financial contagion, and a panel model of spatial measurement was constructed using data from nine major economies. Without considering spatial influences, a general panel regression model was constructed and compared with other indicators. On this basis, four spatially weighted matrices were proposed, and SAR and SEM were compared and analyzed. Table 5 shows the comparison of the four spatial weight matrices with other weight matrix test results.

The coefficients of different types of explanatory variables were simulated by the MATLAB software, and nine models (M1-M9) were obtained. The specific coefficient fit is shown in Tables 6 and 7, and the fit of these nine models is shown in Figure 9.

By simulating the coefficients of nine different types of explanatory variables, the following conclusions were drawn: (1) The coefficients of different types of capital flow variables were positively correlated, which was basically consistent with previous research. In financial risk, risk spillovers from capital flows were often accompanied by sharp changes in capital flows, which suggested that the higher the share of foreign direct investment (FDI) in the global economy, the more vulnerable it is to financial risks. (2) The coefficients of other variables of the exchange rate were obviously positive, which indicated that the higher the value of a country's currency against the dollar, the greater its role in financial risk. (3) The coefficients of other variables of inflation were obviously positive, and its essence was that the total social demand is greater than the total social supply. If an economy has a higher inflation rate than its trading country, its consumers would gravitate towards products other than it, thereby reducing its exports. As a result, its capital structure becomes unstable and more susceptible to financial risks. (4) It described the negative value of the coefficient of the variable of the economic cycle, which illustrated the counter-cyclical nature of the risk spillover of financial risks. This result was consistent with the "monsoon" phenomenon of financial contagion. (5) Credit risk and liquidity risk factors were positively correlated, which showed that the risk space spillover caused by the European debt crisis is often related to credit risk and liquidity risk, so it is also the focus of current scholars.

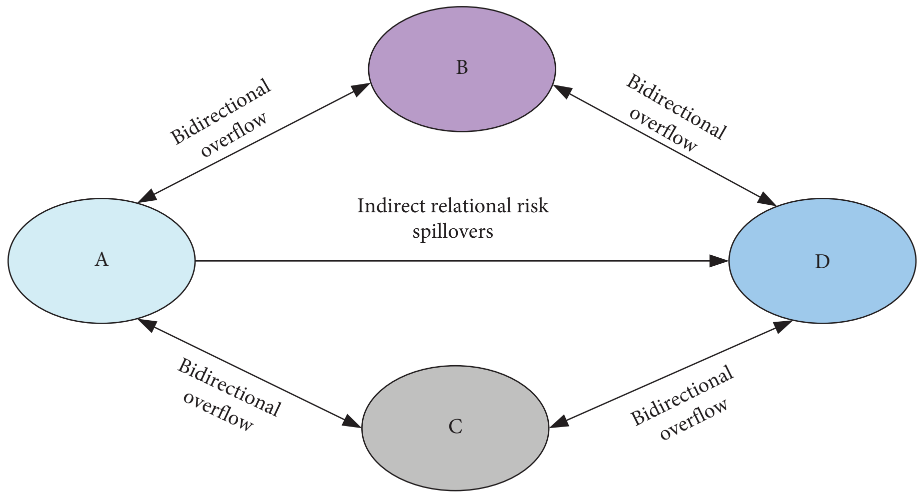

Figure 7: Financial risk spillover diagram.

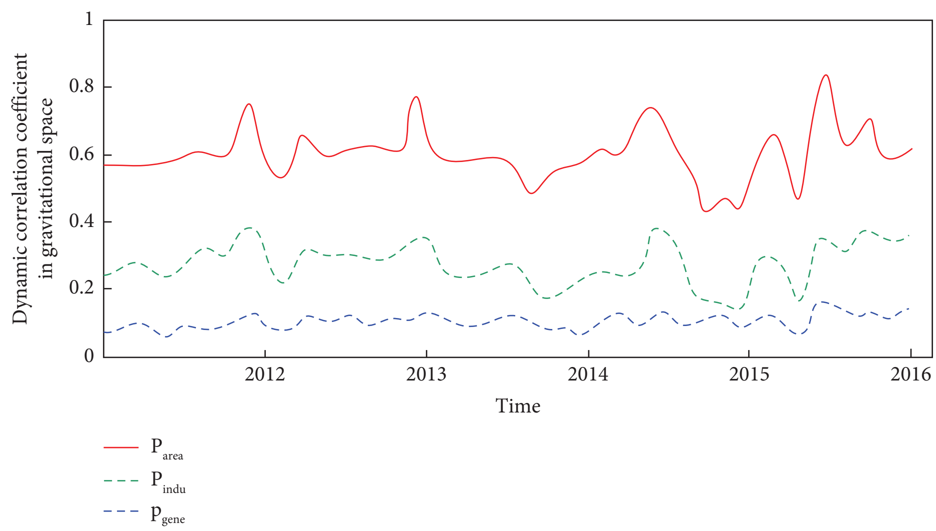

Figure 8: Gravitational space dynamic correlation coefficients.

Table 4: Explanatory variable symbols and their definitions.

Serial no.	Symbol	Variable name
1	Cflow	Capital flows
2	Exchange	Exchange rate
3	cpi	Inflation
4	liqu	Liquidity risk
5	Ffree	Financial market openness
6	Cycle	Economic cycle
7	Credit	Credit risks
8	Tfree	Openness of real economy

Table 5: Comparison of test results of the spatial weight matrix with other weight matrices.

	W_g	W_p	W_{ge}^t	W_{ge}^f
Moran's I	0.2712	0.3804	0.5124	0.6678
Z(I)	17.30312***	12.8839***	20.8493***	24.9698***
LMlag	1 72.0077***	318.5854***	554.8687***	863.4125***
LMerr	228.2113***	191.3147*	419.4702***	649.6014***

Note. *** indicates passing the 1% significance level test.

Table 6: Normal panel model and economic spatial weight matrix model of geographic and political regions.

	Common panel model (M1)	W_g SAR model (M2)	W_g SEM model (M3)	W_p SAR model (M4)	W_p SEM model (M5)
W_gY		−0.2361	0.6642		
W_pY				0.4723	0.7072
Cflow	0.06782	0.0725	0.0425	0.0703	−0.0632
Exchange	0.0485	0.826	0.0635	0.8156	0.2354
cpi	0.0102	1.421	0.1524	1.5342	0.5763
liqu	0.0076	0.0115	0.0075	0.0139	0.0013
Ffree	0.1568	0.3268	0.1136	0.29654	0.0641
Cycle	−0.0035	−1.1925	−0.7854	−12.2534	−0.6213
Credit	0.0968	0.1306	−0.0065	0.1354	0.0234
Tfree	−0.1435	−0.5314	−0.1318	−0.4635	−0.6341

Table 7: Gravitational space weights matrix model in generalized multidimensional economic space.

	W_{ge}^t SAR model (M6)	W_{ge}^t SEM model (M7)	W_{ge}^f SAR model (M8)	W_{ge}^f SEM model (M9)
W_{ge}^tY	0.8562	0.7132		
W_{ge}^fY			0.9125	0.8965
Cflow	0.0465	0.0365	0.0245	0.0356
Exchange	0.1963	0.2113	0.1341	0.29923
cpi	0.2451	0.3226	0.0798	−0.0635
liqu	0.0065	0.0028	0.0084	0.0118
Ffree	0.1235	0.0235	0.1534	0.2498
Cycle	−0.3214	−0.4825	−0.0008	−0.3562
Credit	0.01365	0.0245	0.0073	0.0038
Tfree	−0.1635	0.1952	−0.1478	−0.2706

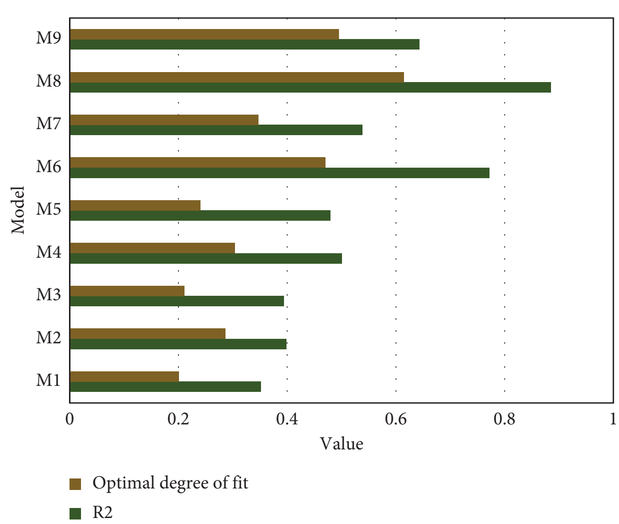

Figure 9: Model fit comparison.

4. Conclusions

Under the current economic conditions, the role of space between economic units is becoming more and more obvious. Traditional econometric models ignore the impact of this space. At the same time, under the current economic conditions, many new characteristics of spatial interaction have emerged, such as multidimensional, mixed, and asymmetric. On the basis of information theory and spatial econometrics, a DAI spatial weight matrix based on transferred entropy was established and a spatial econometric model was established on this basis. By capturing the spatial effects of information between financial markets, the accuracy of forecasts can be further improved. Although spatial econometrics has been developed for more than four decades, its application in the field of finance has not yet yielded much result. Many theories are still immature and have not yet formed a relatively complete system. This paper combined information theory with complex network theory to establish a new economic spatial theory of information transmission for practical problems in financial markets. In future research, a deeper understanding of the multimedia technology in Health Cloud's biometric authentication and data management system would be carried out, so as to make the financial risk model more operational.

Data Availability

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Conflicts of Interest

The authors declare that they have no conflicts of interest in this paper.

Acknowledgments

This work was supported by the Social Science Foundation of Shaanxi Province of China (grant no. 2019D009); the Shaanxi Province of China, Department of Education

Project of Philosophy and Social Sciences Key Research Base (grant no. 19JZ052); the Social Science Foundation of Shaanxi Province of China (grant no. 2019S019); the Shaanxi Province of China, Department of Education Scientific Research Plan Project (grant no. 19JK0646); and the Soft Science General Project of Shaanxi Province Innovation Capability Support Plan (grant no. 2021KRM057).

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