

# Research on the Financial Integration Process of the Belt and Road Countries

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## Abstract

The proposal of the "Belt and Road" broke the restriction of "regional barriers", making countries along the route increasingly close in finance and deepening regional financial integration. The study of "Belt and Road" financial integration is of great significance for policy formulation. To study the global and regional financial integration of countries along the "Belt and Road", this paper selects the perspective of the stock market and adopts a nonlinear Time-varying factor model. The study found that: 1) The stock markets of countries along the "Belt and Road" show both regional integration and global integration in the full sample interval. 2) Sub-sample logt regression results show that before the "Belt and Road" initiative, the stock markets of the countries along the route showed only global integration. After the proposal of the "Belt and Road" initiative, the stock markets of the countries along the route have both global integration and regional integration. 3) The speed of global integration in countries along the "Belt and Road" is showing a downward trend, while the speed of regional integration is showing an upward trend. 4) Although, before the "Belt and Road" initiative was proposed, there was no overall regional integration feature in the stock markets of countries along the route, but according to cluster analysis, three sub-samples of convergence are obtained. In the future, countries along the route should actively strengthen regional financial integration by building multi-level and rich-functioning financial markets, and at the same time establish a long-term effective financial risk control mechanism to ensure the stable operation of regional financial cooperation.

## Keywords

"Belt and Road"; Financial Integration; Nonlinear Time-varying Factor Model; Convergence Club.

## 1. Introduction

The United States has always had a huge influence on global financial markets. After the outbreak of the subprime mortgage crisis in 2008, many countries in the world gradually realized the disadvantages of the existing international financial system centered on the United States, and began to take measures to gradually reduce their dependence on the United States and the dollar. The world economic and financial pattern is undergoing profound changes. After the financial crisis, China's financial market also accelerated the pace of opening-up. During his visits to Kazakhstan and Indonesia at the end of 2013, General Secretary Xi Jinping proposed the strategic concept of jointly building the "New Silk Road Economic Belt" and the "21st Century Maritime Silk Road" (collectively called the "Belt and Road"). With the help of the Belt and Road Construction platform, China is actively developing economic partnerships with countries along the Belt and Road, and vigorously strengthening communication and exchanges in finance and trade with countries or regions along the Belt and Road, so as to achieve the goals of stable economic development, financial cooperation and unimpeded trade in the regions

along the Belt and Road. The Belt and Road Initiative is not only a milestone for China's reform and opening-up in the new era, but also of great significance to today's economic globalization and world development.

In the process of "Belt and Road" construction, finance is an indispensable fulcrum and link to leverage and connect countries, as well as the basic condition for the construction of the "five links" system. With the promotion of the belt and Road Initiative, China is speeding up the opening of its financial market, and has carried out increasingly close financial cooperation and exchanges with countries (regions) along the route. The financial cooperation between China and countries (regions) along the Belt and Road mainly includes the following aspects: first, high-level cooperation at the level of central banks, second, the establishment of multilateral financial institutions, third, cooperation in establishing mutual financial institutions and capital markets. After years of practice and exploration, financial cooperation among countries along the Belt and Road has become increasingly close, the connection of financial activities has been increasingly strengthened, and the linkage between financial markets has been gradually strengthened.

The increasingly close financial cooperation and connection among countries along the belt and Road has deepened the degree of regional financial integration, which has a profound impact on regional economy and even the global economy. Many theories and researches show that financial integration is of great significance. From the perspective of risk diversification, financial integration gives investors access to a richer range of financial assets and instruments, thus increasing the diversity of their portfolios. From the perspective of capital allocation, financial integration can reduce the transaction cost of assets and improve the efficiency of capital allocation. From the perspective of economic growth, financial integration will bring about the overall improvement of financial development level in the region, and thus promote the economic growth of countries in the region. From the perspective of financial stability, the ECB believes that financial market integration can more effectively allocate risks and enhance financial stability by promoting price stability. Shimizu Satoshi (2013) pointed out that regional financial integration can reduce dependence on unstable out-of-region funds by promoting intra-regional financing. [1] However, some scholars believe that financial integration will aggravate instability. Seen from the occurrence of previous financial crises, financial integration is one of the important factors leading to the rapid spread of financial crisis among various economies. But most scholars believe that the benefits of financial integration far outweigh the risks.

In view of the significance of financial integration, financial integration has always been the focus of scholars, but the existing studies mostly focus on the financial integration of the European Union and the Asia-Pacific region, so far, almost no scholars have carried out research on the financial integration of countries along the "Belt and Road". Secondly,  $\beta$  convergence and  $\sigma$  convergence, unit root test, cointegration analysis and panel unit root test with random trend are used in financial integration research. These traditional methods cannot fully capture the dynamic process of financial integration. At the same time, different degrees and modes of financial integration have different impacts on the stability of domestic financial system and the ability of economies to absorb external shocks. It is very important to analyze the global and regional integration of countries along the Belt and Road for policy making. The stock market is a very important part of the financial market, and the integration of the stock market is an important embodiment of the integration of the financial market, which is of great significance to optimize the distribution efficiency of financial resources. Based on this, this paper adopts the nonlinear Time-varying factor model proposed by Phillips and Sul(2007)[2] to study the process of global and regional integration of stock markets in countries along the "Belt and Road".

## 2. Literature Review

As for the concept of financial integration, there is not a relatively uniform definition. However, from the perspective of research, financial integration can be regarded as the mutual penetration and influence of financial activities among countries (regions), and form a linkage overall development trend. Further explanations of financial integration can be made in two ways. From the perspective of liquidity, financial integration means that each economic entity can carry out the transaction of financial assets with almost no transaction cost or without restriction. From the perspective of substitution, financial integration means that financial assets within and outside a country (region) are highly substitutable. [3]

Indicators to measure financial integration can be summarized into three categories, namely price indicators, quantitative indicators and supervisor-based indicators.

The first type of price indicator is usually reflected in the interest rate parity conditions of the money market or the coordinated changes of asset returns in the stock and bond markets. Aarti Rughoo et al. (2016)[4], Kim and Lee et al. (2012)[5] studied financial integration in East Asia by using covered interest rate parity (UIP). Tang (2010)[6] used non-covered interest rate parity to study the integration of East Asian countries and the integration of financial markets in the five ASEAN countries and the United States. Fung and Yu (2010)[7] and Boubakri (2015)[8] used DCC-GARCH model to study the degree of stock market integration in ASEAN region. Quantitative indicators mainly include correlation between savings and investment, correlation between consumption and cross-border capital flows (cross-border financial transactions). The third type is usually based on whether there are capital and legal restrictions, such as restrictions on foreign ownership.

As for the research methods of financial integration, the traditional research mostly adopts  $\beta$  convergence and  $\sigma$  convergence, unit root test, cointegration analysis or panel unit root test with random trend. Zhang T and Matthews K (2018) used  $\beta$  convergence to study the degree of financial integration in five ASEAN countries from the perspective of bank competitiveness. [9]Cheung et al. (2005) used unit-root test and generalized least square method to test the untenable-rate Parity among China, Hong Kong and Taiwan. [10]Byung-Joo Lee (2019) used panel unit root test and panel co-integration to test whether there is a common trend in Asian financial markets. [11]Rui Dias et al. (2019) used panel co-integration to study the financial integration of Latin American emerging markets in the context of Internet and subprime crisis. [12]

Many scholars argue that there are many problems with traditional research methods. Islam(2002) pointed out that  $\beta$  convergence and  $\sigma$  convergence are more suitable for growth models, and there are some problems in the empirical testing process, especially when convergence exists in some countries and not in other countries. [13] Phillips and Sul (2009) believed that when the convergence rate was less than the divergence rate, the co-integration test could not identify the gradual convergence process. [14] Apergis et al. (2014) pointed out that these methods could not test convergence when there were multiple steady-state equilibria in the sample data. [15]

Phillips and Sul (2007) [2] proposed panel convergence test, which is a nonlinear Time-varying factor model. The model has several significant advantages. First, the model allows the existence of individual heterogeneity and the variation of heterogeneity over time. Second, the model does not require the assumption of stationarity. Additionally, the clustering method can test whether there is convergence in the sub-samples, and there is no need to set this in advance, because the system will automatically conduct screening and testing, so as to complete the clustering and grouping of the big data sample. Therefore, the P&S method is used by many scholars to study the convergence of different areas of financial markets. Apergis et al. (2014) used the P&S method to explore the convergence of international stock markets. The empirical

results show that the stock markets of 37 countries (out of a total of 42 countries) form a convergent subset. Regional integration is stronger when interest rates with longer maturities are considered. [15]Caporale et al. (2015) adopted the method proposed by Phillips and Sul to test the convergence of stock returns on monthly stock price indexes of five European Union countries (Germany, France, the Netherlands, Ireland and the United Kingdom) and the United States from 1973 to 2008. The study found four convergence clubs. [16] Aarti Rughoo and Kefei You(2016) used this model to study the degree of regional and global financial integration in Southeast Asia from 2004 to 2012. The results show that there was global and regional financial integration in southeast Asian money market before 2008, but after the financial crisis, global integration came to an abrupt end, and regional financial integration, though slow, still existed after the crisis. There is both global and regional integration in the Bond market in Southeast Asia, but in comparison, the degree of regional financial integration is higher after 2008. In addition, there are multiple levels of convergence in Southeast Asia. [4] Hu Zongyi et al. (2016) used nonlinear Time-varying factor model to study the convergence of China's rural financial development, and the study showed that there was no convergence in China's rural financial development as a whole. [17] Sun Xiaohua et al. (2018) proposed a club convergence identification method for urban economic growth based on nonlinear Time-varying factor model, and conducted empirical tests on more than 300 administrative regions in China. [18] Caporale et al. (2019) used the P&S model to investigate the integration of global and regional stock markets in Asia from the aggregate and industry levels. It is found that throughout the sample period and the two sub-sample periods (with the 2008 financial crisis as the cut-off point), Asian stock markets generally show the characteristics of global integration and regional integration, but the convergence speed decreases after the financial crisis. Industry-level convergence tests show that despite overall convergence, the oil and gas, healthcare, and technology industries do not experience panel convergence over any sample period. [19]

Financial integration has always been a hot topic for scholars at home and abroad. However, existing researches mostly focus on the financial integration of eu and Asia-Pacific region. At present, almost no scholars pay attention to the financial integration of countries along the belt and Road. Secondly,  $\beta$  convergence and  $\sigma$  convergence, unit root test, cointegration analysis and panel unit root test with random trend are used in financial integration research. These traditional methods cannot fully capture the dynamic process of financial integration.

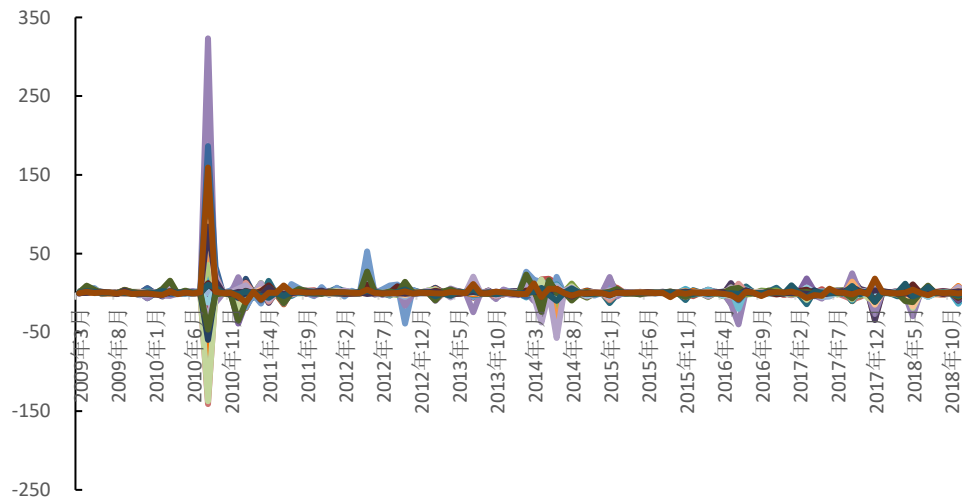
Therefore, this paper adopts the nonlinear Time-varying factor model proposed by Phillips and Sul to study the dynamic process of global and regional integration of stock markets in countries along the "Belt and Road", aiming to make up for the lack of literature in these two aspects. In addition, considering that the proposal of the Belt and Road Initiative may affect the financial integration process of the countries along the belt and Road, this paper will examine the regional integration and global integration of the stock markets of the countries along the Belt and Road initiative before and after the proposal.

### 3. Current Situation Analysis of Financial Integration of Countries Along the Belt and Road

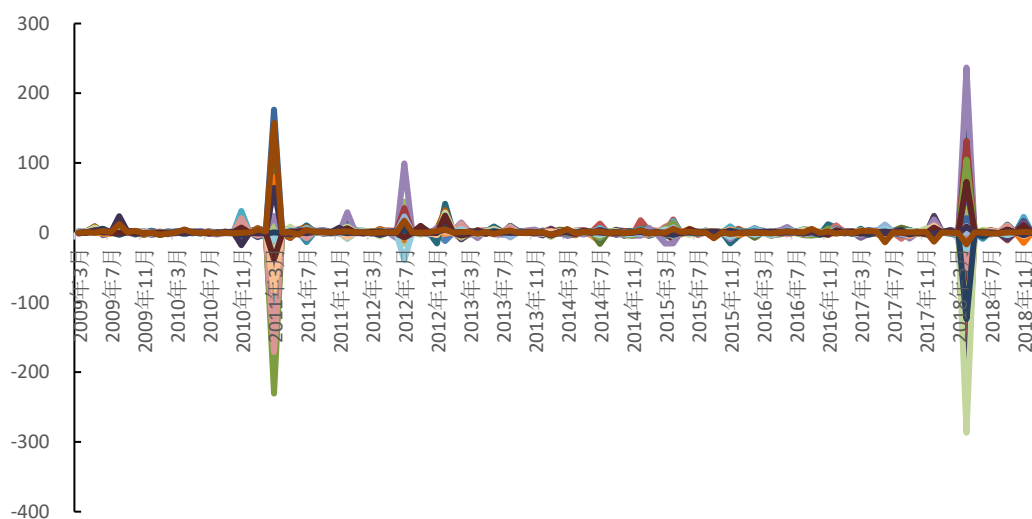
With the promotion of the "Belt and Road" Initiative, the capital markets of countries along the belt and Road are increasingly open, the financial activities of countries in the region are increasingly connected, the financial markets are becoming more and more interconnected, and the stock markets are also becoming more and more interconnected.

In order to further describe the integration process of stock markets in countries along the belt and Road, this paper draws figures of the difference of stock index returns between countries along the Belt and Road and China, as well as the difference of stock index returns between countries along the Road and the United States. As can be seen roughly from the figures, when

China is taken as the benchmark, stock index returns of countries along the belt and Road show a gradual convergence trend. However, when taking the United States as the benchmark, the trend of stock index yields in countries along the Belt and Road is more complex, showing a convergence trend before the initiative. After the initiative was put forward, the trend of convergence slowed down and even appeared scattered.



**Fig 1.** The trend of stock index return spread between Belt and Road countries and China (年: Year, 月: Month)



**Fig 2.** The trend of stock index return spread between Belt and Road countries and the United States (年:Year, 月: Month)

## 4. Methodology

### 4.1. Nonlinear Time-varying Factor Model

For the global and regional financial integration of stock markets in countries along the "One Belt and One Road", this paper adopts the index return spread calculated based on the US and the index return spread calculated based on China respectively.

We use  $X_{it}$  to represent the index yield spread, where  $i$  represents economies along the Belt and Road,  $i=1,...,N$ , and  $t$  represents time span,  $t=1,...,T$ . According to Phillips and Sul (2007), panel data can generally be decomposed into the following equation:

$$X_{it} = g_{it} + a_{it} \quad (1)$$

Where  $g_{it}$  is the relatively stable component of  $X_{it}$ , while  $a_{it}$  represents the temporary component of  $X_{it}$ .  $g_{it}$  and  $a_{it}$  may both contain the common trend and individual heterogeneity. To get the common trend, we can transform Equation (1) and get Equation (2).

$$X_{it} = \frac{g_{it} + a_{it}}{\mu_t} \mu_t = \delta_{it} \mu_t \quad (2)$$

Both  $\delta_{it}$  and  $\mu_t$  change over time.  $\delta_{it}$  is not only a proxy variable of individual heterogeneity with Time-varying characteristics, but also contains random component  $\epsilon_{it}$ .  $\mu_t$  is a common growth path that remains relatively stable over time. Equation (2) is the nonlinear Time-varying factor model containing both a common trend term  $\mu_t$  and Time-varying individual heterogeneity  $\delta_{it}$ .

In a nonlinear Time-varying factor model, the Time-varying factor  $\delta_{it}$  is an indicator used to measure whether  $X_{it}$  converges to  $\mu_t$  over time. If  $\delta_{it}$  converges to some constant  $\delta$ , it means that  $X_{it}$  converges to  $\mu_t$  over time, meaning that the stock index spread in all countries converges to the same level. Specifically, if  $X_{it}$  based on the US has convergence, it indicates that the stock markets of countries along the Belt and Road show global integration. While the convergence of  $X_{it}$  based on China indicates that the stock markets of countries along the Belt and Road show regional integration.

To test whether  $\delta_{it}$  tends to converge, Phillips and Sul (2007) defined the relative transfer coefficient  $h_{it}$ , as shown in Equation (3).

$$h_{it} = \frac{X_{it}}{\frac{1}{N} \sum_{i=1}^N X_{it}} = \frac{\delta_{it}}{\frac{1}{N} \sum_{i=1}^N \delta_{it}} \quad (3)$$

The relative transfer coefficient  $h_{it}$  has two meanings. On the one hand,  $h_{it}$  can reflect the long-term convergence of stock index return spreads in countries along the belt and Road. When  $h_{it} \rightarrow 1$ , it means that there is convergence among stock index return spreads in countries along the Belt and Road, that is, there is global financial integration or regional financial integration. On the other hand,  $h_{it}$  can reflect changes in index return spreads and deviations from average growth over time across countries. If the countries along the "Belt and Road" have stable convergence, then when  $t$  tends to infinity,  $H_t = \frac{1}{N} \sum_{i=1}^N (h_{it} - 1)^2 \rightarrow 0$ , that is, the variance of the cross section tends to zero when  $t$  tends to infinity.

Phillips and Sul (2007) first constructed a semi-parametric model, as shown in Equation (4), so as to build a null hypothesis for testing convergence later.

$$\delta_{it} = \delta_i + \frac{\sigma_i \xi_{it}}{L(t)t^\alpha} \quad (4)$$

Where,  $\delta_i$  is an individual time-invariant parameter, so it is fixed and does not change with time.  $\sigma_i$  is the scale parameter of heterogeneity.  $\xi_{it}$  is assumed to be independent and identically distributed (IID).  $L(t)$  is a slowly varying function, and  $L(t)$  tends to infinity as  $t$  tends to infinity.  $\alpha$  is the rate of decay, reflecting the rate of convergence of  $\delta_{it}$ . From the semi-parametric model, it can be concluded that  $\delta_{it} \rightarrow \delta_i$  as long as  $\alpha \geq 0$ .

Through the above deduction, the test of convergence is transformed into the following hypothesis test. The null hypothesis and alternative hypothesis are set as follows.



$$H_0: \delta_i = \delta \text{ and } \alpha \geq 0$$

$$H_A: \delta_i \neq \delta \text{ or } \alpha < 0$$

$H_0$  means that the whole sample converges to the same level. In this paper, stock markets of countries along the belt and Road represent global (or regional) integration.  $H_A$  means that at least one country does not converge with the others. In order to test the null hypothesis of convergence, the equation is used for regression.

$H_0$  means that the whole sample converges to the same level, which in this paper represents that the stock markets of countries along the "Belt and Road" show global (or regional) integration.  $H_A$  means that at least one country does not converge with the others. To test the null hypothesis of convergence, we use equation (5) to conduct regression test.

$$\text{Log}\left(\frac{H_1}{H_t}\right) - 2\log L(t) = \hat{a} + \hat{b}\log t + \hat{\mu}_t, t = [rT], [rT] + 1, \dots, T \quad (5)$$

Where, Phillips and Sul (2007) set the slow-changing function form as  $L(t) = \log(t + 1)$ . The starting point of the data is  $t = [rT]$ , where  $r$  is a quantile. Through Monte Carlo simulation, Phillips and Sul(2007) concluded that when the amount of data is relatively small ( $T \leq 50$ ),  $r$  is 0.3. For a large amount of data ( $T \geq 100$ ),  $r$  is 0.2. In regression, let the fitting coefficient  $\hat{b}$  of  $\log t$  be equal to  $2\hat{a}$ .

Heteroskedasticity and Autocorrelation Consistent (HAC) unilateral T-test was used to test the null hypothesis. If  $t > -1.65$ , the null hypothesis of convergence could not be rejected at the significance level of 5%. If  $t < -1.65$ , the null hypothesis of convergence is rejected at the significance level of 5%, and the existence of club convergence needs to be further tested through the club convergence algorithm.

## 4.2. Clustering Algorithm and Convergence Club

Rejecting the null hypothesis of full-sample convergence does not mean that there is no convergence in the subsets of panel data. Therefore, Phillips and Sul(2007) proposed a club clustering algorithm to test whether there is convergence in the sub-samples. Specifically, the algorithm completes club clustering by sorting, determining core groups and adding members according to certain rules. The algorithm is flexible and allows for all possible outcomes.

The logt test based on nonlinear Time-varying factor model is the basis of club algorithm. The club algorithm consists of the following four steps.

### Step1 Sorting

In the panel data, the sorting is based on the mean of individual observations during the last period. The formula for calculating the mean value is defined as:

$$(T - [Ta])^{-1} \sum_{t=[Ta]+1}^T X_{it}, a = 1 - f$$

For the time span  $f$  of the last observation, it is generally  $1/2$  or  $1/3$ .

### Step2 Determining core groups

According to the sorting results of Step1, firstly find the individual with the highest mean value of observation and include it into the core group. Then, according to the descending order of the mean value of observation, one other individual is added to the core group one by one to form alternatives of the core group. Logt test is conducted for each alternative group. The formation of alternative groups is stopped until the value of the obtained T-statistic is less than the critical value  $-1.65$  at the 5% significance level for the first time. We identified the core

group in  $k$  individuals. In order to reduce the probability of Type I error, under the condition of  $t > -1.65$ , we look for the individuals that maximized the value of T-statistic, that is, the following condition is satisfied.

$$k^* = \arg \max\{t_k\}, \text{ s. t. } \min\{t_k\} > -1.65$$

If  $k$  is 2 and the T-statistic obtained by logt regression is less than -1.65, the first research object is removed and the above process is repeated from the second research object. If the above situation still occurs from the second research object, the second research object is removed and the above steps are repeated from the third research object until the value of  $t$  statistic is greater than -1.65. If neither is satisfied, there is no convergence club in the subsample.

#### Step3 Identify convergence clubs

Logt test is performed on the remaining individuals not included in the core group to determine whether they are in the same club as the core group. Specifically, logt test is performed on the remaining individuals one by one together with the core group, and the members of the convergence club are determined at a certain significance level, that is, whether the value of their T-statistic satisfies  $t > c$ . All regions satisfying  $t > c$  are merged to form a new club, and logt test is performed on this new club. If  $t > -1.65$  is satisfied, the new club is a convergence club.

Through Monte Carlo simulation, Phillips and Sul (2007) concluded that when the sample time span was less than 50, the significance level of 50% is adopted. When the sample time span is greater than 100, the significance level of 40% is adopted. When the sample time span is greater than 200, the significance level of 20% is adopted. By choosing different levels of significance for different time spans, we achieve a balance between making Type I and Type II errors.

#### Step4 Stop rules

After the first convergence club member is determined, logt test is performed on the remaining members not included in the convergence club. Stop if the value of the T-statistic is greater than -1.65. Otherwise, repeat Step 1-Step 3 for the remaining areas to find the next convergence club. If a new core group can be found, a new club will be constructed; otherwise, convergence clubs cannot be formed in the remaining countries.

### 4.3. Data

Referring to the practices of Park(2015) [20] and Caporale(2019) [21] et al., this paper adopts stock market return rate to study the global and regional financial integration of countries along the Belt and Road. Specifically, the difference between stock index returns of countries (regions) along the Belt and Road and that of The United States is used as the index of global integration, and the difference between stock index returns of countries (regions) along the Belt and Road and that of China is used as the index of regional integration, and the convergence test is conducted on this basis.

The Belt and Road initiative covers 65 countries in Southeast Asia, South Asia, East Asia, West Asia and North Africa, and Central and Eastern Europe. As most countries along the Belt and Road are developing countries, the development of capital markets in these countries is relatively backward. Therefore, based on the availability of data, this paper will focus on 36 countries along the "Belt and Road" and study the global and regional integration of stock markets in these countries (regions). In this paper, the data of stock return rate are obtained from wind database, the data frequency is monthly, and the sample data range is 2009M03-2018M12. If the stock markets of countries along the Belt and Road were globally integrated, the spread of stock returns calculated based on the US would converge. If these markets are regionally integrated, the equity yield differential calculated based on The Chinese stock yield should converge.



## 5. Empirical Results

### 5.1. The Overall Convergence of the Stock Market

Before the convergence test, we first used HP filter to remove the periodic fluctuation part of each time series, and only retained the trend part.

The results are shown in Table 1 and Table 2. The stock markets of countries along the Belt and Road demonstrate both regional and global integration in the full sample range. The Belt and Road Initiative was put forward at the end of 2013, and began to play its role in 2014. Therefore, we takes 2014 as the cut-off point of the Belt and Road Initiative and studies the regional integration and global integration of countries along the Belt and Road before and after the initiative was put forward.

The logt regression results of sub-samples show that the stock markets of countries along the Belt and Road show the characteristics of global integration before and after the initiative, but the speed of global financial integration slows down after the initiative.

For the regional integration of stock markets in countries along the belt and Road, before the initiative was put forward, the estimated value of  $b$  obtained by logt regression was less than 0, and the T-statistic is -6.54, far less than the critical value -1.65 under the significance level of 5%. Therefore, the null hypothesis of convergence is rejected. That is, there is no regional integration in the stock markets of countries along the Belt and Road before the Belt and Road Initiative was put forward. After the Belt and Road Initiative was put forward, the stock market of countries along the belt and Road has been significantly integrated and the process of regional integration has been accelerated. The proposal of the Belt and Road Initiative breaks the restrictions of regional barriers, enables countries along the route to establish long-term mutually beneficial and friendly business relations, deepens and strengthens financial cooperation with each other, expands the total amount of financial capital, and promotes the efficient allocation of capital as well as the depth of the market, and accelerate the regional integration of stock markets in countries along the route.

"Area" initiative of broke the limit "regional barriers", make along the country to establish long-term mutually beneficial friendly business relations, deepening to strengthen the financial cooperation between each other, to expand the amount of financial capital, promoting the efficient allocation of capital as well as the depth of the market, stock market regional integration of countries along the speed.

**Table 1.** The result of regional financial integration in countries along the Belt and Road

	$\hat{b}$	t-statistic
200903-201812	1.37	3.63
Before the Belt and Road Initiative (200903-201312)	-3.06	-6.54
After the Belt and Road Initiative (201401-201812)	1.11	1.51

Note: The HAC t-statistic follows an asymptotically normal distribution, and its critical value is -1.65 at the significance level of 5%. When the value of t-statistic is less than this value, the null hypothesis is rejected.

In logt regression, we set the slow-changing function as  $L(t)=\log(t+1)$ . In order to avoid the influence of different function forms on the results, three different slow functions,  $L(t)=\log t$ ,  $L(t)=\log(\log(t))$  and  $L(t)=\log(\log(t+1))$ , are used to test the robustness of the results, and the results are shown in Table 3 and Table 4. The results of robustness test are consistent with those of the benchmark model.

**Table 2.** The result of global financial integration in countries along the Belt and Road

	$\hat{b}$	t-statistic
200903-201812	1.53	4.76
Before the Belt and Road Initiative (200903-201312)	1.31	2.53
After the Belt and Road Initiative (201401-201812)	0.87	7.01

Note: The HAC t-statistic follows an asymptotically normal distribution, and its critical value is -1.65 at the significance level of 5%. When the value of t-statistic is less than this value, the null hypothesis is rejected.

**Table 3.** Robustness test results of regional financial integration in countries along the Belt and Road

	L(t)=logt		L(t)=log(log(t))		L(t)=log(log(t+1))	
	$\hat{b}$	t-statistic	$\hat{b}$	t-statistic	$\hat{b}$	t-statistic
200903-201812	1.35	3.60	1.49	3.95	1.50	3.98
Before the Belt and Road Initiative (200903-201312)	-3.08	-6.60	-2.98	-6.40	-2.96	-6.33
After the Belt and Road Initiative (201401-201812)	1.08	1.47	1.19	1.61	1.21	1.64

Note: The HAC t-statistic follows an asymptotically normal distribution, and its critical value is -1.65 at the significance level of 5%. When the value of t-statistic is less than this value, the null hypothesis is rejected.

**Table 4.** Robustness test results of global financial integration in countries along the Belt and Road

	L(t)=logt		L(t)=log(log(t))		L(t)=log(log(t+1))	
	$\hat{b}$	t-statistic	$\hat{b}$	t-statistic	$\hat{b}$	t-statistic
200903-201812	1.55	4.81	1.41	4.39	1.39	4.35
Before the Belt and Road Initiative (200903-201312)	1.28	2.34	1.38	3.27	1.41	3.45
After the Belt and Road Initiative (201401-201812)	0.84	7.07	0.95	6.89	0.97	6.83

Note: The HAC t-statistic follows an asymptotically normal distribution, and its critical value is -1.65 at the significance level of 5%. When the value of t-statistic is less than this value, the null hypothesis is rejected.

## 5.2. Convergence Clubs

Because of the existence of non-convergent members and convergent clubs, the application of logt test may not be able to identify the overall convergence. Through testing the overall convergence of the stock markets of countries along the Belt and Road, we find that the stock markets of countries along the Belt and Road did not have significant characteristics of regional integration before the initiative was put forward, but this does not mean that there is no integration phenomenon in the sub-samples. Therefore, we further studied the possible convergence clubs based on the clustering algorithm proposed by Phillips and Sul, and the results are shown in Table 5. Through clustering algorithm, we obtains three groups of convergence clubs. The first group contains 21 countries, including UAE, Pakistan, etc. The estimated value of b is -0.04, and the convergence speed is relatively slow. The second group contains 5 countries, including Indonesia, Malaysia, etc. The estimated value of b is 0.036, with

moderate convergence rate. The third group contains 10 countries, including Sri Lanka, Singapore, etc. The estimated value of  $b$  is 1.14, showing a faster convergence rate.

**Table 5.** The result of convergence clubs

	Contains	$\hat{b}$	t-statistic
Club 1	United Arab Emirates, Pakistan, Philippines, Egypt, Qatar, Bulgaria, Thailand, Saudi Arabia, India, Lithuania, Romania, Israel, Vietnam, Kuwait, Oman, Bahrain, Slovakia, Slovenia, Jordan, Serbia, Greece	-0.04	-0.06
Club 2	Indonesia, Malaysia, Turkey, Latvia, Poland	0.036	0.15
Club 3	Sri Lanka, Singapore, Lebanon, Croatia, Hungary, Czech Republic, Kazakhstan, Russia, Ukraine, Cyprus	1.14	1.43

Note: The HAC t-statistic follows an asymptotically normal distribution, and its critical value is -1.65 at the significance level of 5%. When the value of t-statistic is less than this value, the null hypothesis is rejected.

## 6. Conclusions and Suggestions

Financial system is the core medium to promote resource allocation under modern economic conditions, and its efficiency is the foundation to realize effective resource allocation. This paper concludes that the level of regional financial integration in countries along the Belt and Road presents an upward trend, while the level of global financial integration presents a downward trend. The Belt and Road initiative has broken the restriction of regional barriers, promoted the efficient allocation of regional financial resources and the deep integration of capital market, and continuously improved the level of regional financial integration.

Financial integration has a profound impact on regional and even global economy, and is of great significance to risk diversification, capital allocation efficiency improvement and economic growth. Therefore, it is necessary to further promote the regional financial integration process of countries along the Belt and Road by building a multi-level financial market with rich functions, continuously deepening the reform of financial institutions, optimizing the financial system, and improving relevant supporting services.

With the diversification of regional financial cooperation, the continuous expansion of capital export scale and the increasingly close financial links among countries, other financial risks may appear. Most of the countries along the route are underdeveloped and have fragile financial systems. Therefore, while promoting in-depth financial cooperation among countries and financial market integration, it is necessary to actively expand diversified and multi-level regulatory systems and establish long-term effective mechanisms for financial risk control, so as to ensure the steady operation of regional financial cooperation.

## References

- [1] Satoshi Shimizu, Si Wei. The significance and present situation of financial integration in Asia[J]. Translated collection of Nanyang materials, 2013(03):1-11+72.
- [2] Phillips, P.C.B., & Sul, D.. Transition modeling and econometric convergence tests [J]. Econometric Society, 2007, 75(6):1771-1855.
- [3] Li Zhe. Analysis of financial integration of Beijing-Tianjin-Hebei region based on saving and investment correlation coefficient [J]. Chinese Journal of Management Science, 2012, 20 (S2):869-872.
- [4] Aarti Rughoo, Kefei You. Asian financial integration: Global or regional? Evidence from money and bond markets [J]. International Review of Financial Analysis, 2016, 48.
- [5] Kim, S., & Lee, J. W.. Real and financial integration, real and financial integration in east Asia[J]. Review of International Economics, 2012, 20(2):332-349.

- [6] Kin-Boon Tang. The precise form of uncovered interest parity: A heterogeneous panel application in ASEAN-5 countries [J]. *Economic Modeling*, 2010, 28(1).
- [7] Ip-Wing Yu, Kang-Por Fung, Chi-Sang Tam. Assessing financial market integration in Asia-Equity markets [J]. *Journal of Banking and Finance*, 2010, 34(12).
- [8] Boubakri S, Guillaumin C..Regional Integration of the East Asian Stock Markets: An Empirical Assessment [J]. *Journal of International Money and Finance*, 2015, 57.
- [9] Zhang T, Matthews K. Assessing the degree of financial integration in ASEAN--A perspective of banking competitiveness [J]. *Research in International Business & Finance*, 2018.
- [10] Cheung, Y. -W., Chinn, M.D., & Fujii, E. Dimensions of financial integration in Greater China: Money markets, banks and policy effects [J]. *International Journal of Finance and Economics*, 2005, 10 (2): 117-132.
- [11] Byung-Joo Lee. Asian financial market integration and the role of Chinese financial market [J]. *International Review of Economics and Finance*, 2019, 59.
- [12] Rui Dias, et al. Financial markets of the LAC region: Does the crisis influence the financial integration? [J]. *International Review of Financial Analysis*, 2019, 63.
- [13] Islam, N. What have we learnt from the convergence debate? [J]. *Journal of Economic Surveys*, 2002, 17 (3): 309-362 (07).
- [14] Phillips, P.C. B., & Sul, D.. Economic transition and growth [J]. *Journal of Applied Econometrics*, 2009, 24: 1153-1185.
- [15] Nicholas Apergis, Christina Christou, Stephen M. Miller. Country and industry convergence of equity markets: International evidence from club convergence and clustering [J]. *North American Journal of Economics and Finance*, 2014, 29.
- [16] Guglielmo Maria Caporale, Burcu Erdogan, Vladimir Kuzin. Testing stock market convergence: a non-linear factor approach [J]. *Empirica*, 2015, 42(3).
- [17] Hu Zongyi, Zhao Sheng, Tang Liwei. Convergence of Rural financial development in China [J]. *Statistics & Decision*, 2016(10): 128-132.
- [18] Sun Xiaohua, Cao Yang. Convergence of clubs for urban economic growth: Identification methods and convergence mechanisms-An empirical test from 347 administrative regions in China [J]. *Modern Economic Science*, 2018, 40(06): 14-25+126.
- [19] Guglielmo Maria Caporale, et al. Global and regional stock market integration in Asia: A panel convergence approach? [J]. *International Review of Financial Analysis*, 2019, 65.
- [20] CynYoung Park. Asian Capital Market Integration: Theory and Evidence [J]. *Social science electronic publishing*, 2015.
- [21] Guglielmo Maria Caporale, et al. Global and regional stock market integration in Asia: A panel convergence approach? [J]. *International Review of Financial Analysis*, 2019, 65.