International financial Network and its structural characteristics

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Abstract: In this paper, the author makes an empirical study on the topological structure and related properties of investment networks in international financial markets by using complex network theory . Research Discovery , International Financial Network not only shows a more obvious group structure characteristics and network homogeneity nature , and belong to a typical scale-free network . Although the international financial integration process is advancing gradually , However, the imbalance of financial resource flows caused by financial agglomeration is still more obvious , A handful of international financial Centre Palms The holds most financial resources . where ,China Hong Kong as the most important regional financial centre for Asian financial Markets is an important investment fund in mainland China source , The future relies on China's financial development reform , is expected to become a first-class international financial center .

Keywords: International Financial Network ; Empirical Analysis ; Complex Network ; topology ; Financial Center

1. Bow I Word

as financial liberalization and financial deepening in various countries continue to push , Country The integration process of the inter-financial market is also gradually accelerating . based on financial convergence theory , financial resources between different regions appear in the flow of space on the set . This article wants to study the international financial Market Network structure topology features , analyzing financial integration processes for international financial markets network effects , and financial resources flowing and set across regions The pattern of a cluster . Hong Kong, China as an important regional international financial centre , Effectively connect the mainland and Asian financial markets to the rest of the world .. This article also hopes to study the position and role of China Hong Kong in the entire international financial network ,analyzing its for China The key role of China's financial reform and future prospects for development .

2. Basic concepts and research status

2.1. Basic Description of the financial network

Complex Network , refers to the individual elements within a system as to Node , node through edge , and, under certain rules , the Network that was formed when the . This article selected the world's most important in the international financial Investment Market Country or region : According to the capital flow size) as a network sectiondot , If there is a financial market between two regions : mainly refers to the stock market and bond market) Investment Activities , It is said that there is a connection between these two nodes Department , Take the sum of the financial market investment between the two as a side weight , From this The Complex network built by is known in this article as the international Financial Market Investment Network . This data is mainly from 2014 First half of the year International Monetary Fund (IMF)Collaborative Portfolio survey cpis), CPIs gives the The amount of investment that the surveyed area has for each of the other regional financial markets . Gold the market

investment mainly refers to two regions of the equity securities (Equity Securities) and debenture securities debt securities) Investment Total and .

2.2. The structural characteristics of the financial network , related descriptive indicators and macros view topology

structural characteristics of the financial network , The mainly reflects the of the nodes in the network The connection between and the position of the node in the network , usually have group body structure and hierarchy two . The Community structure refers to the, because each node connections are not as dense as , and in financial networks tend to form several not same group , Group Internal connections more intensive , and groups between each other connections are much thinner . The hierarchy refers to different financial institutions due to size , Credit-borrowing capabilities are different , Render class like system tree diagram , Hierarchical structural features [1] .

for a weighted network , describes the description of financial network features The index mainly includes the following : Clustering factor , node degrees and nodesintensity , with coefficients . where , in a complex network degree The preference of the larger nodes to connect to each other ; clustering coefficients depicting financial networks Envelope structural features , clustering coefficients greater , The more the financial networks tend to group body structure characteristics ; node degrees and node strength depict the node in importance in complex networks .

in modern graph theory, , the macro topology of the network is typically a package of Around : Rules network , Random network , Small World Network and scale free network . where , No scale network mainly refers to the node degree distribution obeys the power law distribution of the Complex network . verified by research , Real network such as Internet , social networking network and inter-bank networking , features multiple scale-free networks [2].

2.3. research status

In recent years , Complex network theory is constantly applied to the epidemiology of infectious Diseases , Club Learn , All areas of financial economics , uses complex network theory to The number of complex individuals or organizations in the real world constructs a relational network and studies its Topology metrics , ability to connect to network structures and nodes Has a clearer and more intuitive understanding . in the field of finance , already numerous Literature Studies on the use of complex network theory trade network and interbank network to P -5] . due to geographical subdivision of financial market investment data is difficult to obtain the original reason , Research literature on investment network structure of international financial markets currently still less ,Schiavo and others in 2007 years used to trade networks and countries The structural characteristics of the inter-financial network have been studied and compared , think both Show Center one around structural features , International Trade Network connection of financial network more closely , but Schiavo Wait for people without an analysis net Benquan Distribution of collaterals , also lacks an in-depth study of the network's local properties '

This article in Schiavo) based on People's research , applying complex analysis tool for Network theory the international financial Market Investment Network was Related research , not only got the node intensity distribution , margin distribution , gather class factor a series of network structural features such as , , and so on ., For internationalInvestment in financial markets and the flow of investment funds across countries Law has a further understanding , also focuses on analyzing China Hong Kong in international

Special locations and key roles in financial networks .

3. Empirical Analysis

3.1. the degree of integration of the financial investment Market

with the BRICS countries represents the vast majority of developing country finance Open continuously deepening , Integration process of international financial markets gradually accelerating , this first Understand and

study this process through network diagrams . because of international voting Capital amount larger , and some data has statistical errors , and Schiavo different Research Methods , This article takes a method of setting different thresholds , with to more clearly study the financial investment market's capital flows . sets The threshold the to the value of the investment amount between nodes , 50% the mean value of , to get Network Diagram and node degree probability distribution . from Diagram 1, 2 unknown , all Financial Investments network connectivity is very good . The degree of tightness between the nodes of the network can be characterized by the network density indicator , network density is the actual save on the network The ratio of the number of sides to the maximum possible number of edges is . +- 2014 Year , network density from 0.713 up to 0.752 , Show integration of international financial markets Level is being elevated to very high levels each year ,Most node states Home is involved in financial investment activities around the world . where , United States , English countries and Luxembourg three countries highest degrees , such as umbrella outward radiation the knot construct also explains New York , London and Luxembourg remain with the rest of the world The more frequent financial market investment links .

to understand the heavy of certain nodes in the international financial network for the entire network to degree , This article first study the rich club of the internet coefficient . weighted :' Rich Club Music Department coefficient Rich - Clubcoefficient ,RCC) refers to net front R Benquan between the highest nodes and the entire network The ratio of the sum of the edge weights between nodes . Bhattacharya 2008) Other people research The rich of the International Trade Network Club, "" ,View International Trade net network existence Rich Club "" , That is, there are a few nodes with a A huge flow of contacts ,The trade between these nodes accounts for the web The high percentage of total trade is . does the financial investment network also exist so that The Rich club of the the is the same as Phenomenon ? based on results ', ' Rich Club Music Department " before " the capital flow relationship between the nine nodes accounts for the entire network capital flow on55°%, remaining nodes only account for 45°%. Map 3 close to one strip parabola , proof Funds Network Rich Club The phenomenon is significant , Several major areas account for most of the world's capital flows .

3.2. an important financial centre in the Inter-financial market

There are three main ways to study node importance in a network ( ) , one is The number of connections to other nodes by one node , that is node degree analysis ;Another is in a weighted network , Is based on the rights of each edge of a node Heavy and ,- node Strength analysis ; The third method of is based on a The number of shortest paths for nodes ,- -------- Medium . three methods with emphasis , to fully understand the importance of each node , This article applies to analyze each of the three methods .

3.3. An important international financial center in the network from Rich Club Music Department

3.3.1. node strength and edge distribution

for Border Rights Network , Benquan cloth reflects not only the importance of nodes in the network , can also explain nodes The strength of the connection between and its distribution characteristics . Cumulative Total investments cloth Fit Results Chart 5) know margin Compliance Power Law distribution , The probability of the Fit density function for f x ^ a . XA + C ^ Kc takes a value of - 8.745 , - 0.108 and 2.545 , The confidence interval for is (-10.77 , -6.717)(-0.161 , -0.054) + 1.543, 3.548) top statistics are 0.99. where , United States , maximum node strength for UK and Luxembourg 6 and the U.S. section Point strength far beyond the United Kingdom other nodes , on the financial market Has a Total capital flow of more than the world total 1/5, is investing in the world Active financial Center .

Maximum strength three regions , as an important regional financial centre , connects the entire Asian financial market . compared to European financial market field , Total Financial investment between Asian countries represents only the total investment of these countries amount 20.3%, far below European countries 82.2% ratio , this says The financial investment relationship between Asian countries is not very deep. , on the one Hand because the overall financial market maturity and international level in European countries is greater than

High , on the other hand, the regional financial cooperation in Asian markets is relatively sluggish after , mainly in less cooperative mechanisms and limited functionality P]. notable for is , China is Hong Kong, China and Macao's most important financial city field investment , 3638 billion and 248 billions of dollars in investment accounted for The total outward investment of both 32% and 48%. China Hong Kong is one of the most important foreign investment objects in the mainland, . 2013 year China

QDII Investment statistics for the Fund show , Hong Kong, China is QDII To the highest Region (accounting for 59.04%), far beyond US (20.6%), Korea (4.61%). Current domestic financial market is still in the development phase , China Hong Kong as a fund-raising financial centre , as an Inward-looking financial intermediary with , from foreign Gao European market) raise funds and inject to domestic market , the Development of financial markets within the country has played an important role in promoting . China Hong Kong finance market is relatively mature , This provides a health for the domestic capital output Healthy Investment environment . so , China Hong Kong as service global second Top financial center of large economy , in the next period of time the financial system has an opportunity for a hyper-normal extension .

3.3.2. The number of network nodes is central

for a Financial Market that represents the flow of investment funds , We need to know which nodes play the bridge. role , connects other countries in the region to the world . to characterize the node's importance by the number of shortest paths for a node is called the center of the interface 'sex betweeness centrality). results show , beautiful Country , Luxembourg and UK are still the most important financial centres , after normalization The center of the number is0.508,0.214, 0.186. in many areas Financial center China Hong Kong , Japan and Singapore are all regions of Asia Mediation Number Center of the highest , is also the most important regional financial center , Big

3.3.3. Uneven Distribution of financial resources

from a global analysis of the financial market network with and the importance of each node , Financial resources in world-generic There is a greater imbalance in the surround . , This is the most widely studied The structural features of the international trading network are in stark contrast to . based on comparative advantage trade theory , Economic cost power drives trade across countries wide expand , The network density and average node degree of the trade network are higher than the financial Market Network . opposite , agglomeration theory of financial resources , the developed area and there is a considerable gap in the mobilization of financial resources in underdeveloped regions . set bit good , Policy Superior country or region , to increase the flow of money aggregation degree ; flow of financial resources between different regions , Financial Capital Source in space [8]. Preliminary analysis of the financial resources Clustering theory , considers that in today's international financial markets , Financial resources indeed is concentrated in very few international financial centres , and most countries Financial resource flow is not frequent . The distribution and flow of financial resources exists

Large imbalance .

3.4. Research on the homogeneity of the financial market network

The homogeneity properties of the network depict the Tendency of interconnected in a complex network with a larger section , to consider weighted network , the function between the node degree of each node and the strength of the average neighbor node. Relationship . as shown 8, Obviously negative correlation , correlation factor -0. 746. analysis results show that , less connected nodes tend to be the same as the centernode contacts , Financial Market Network showing a more obvious homogeneity .

The same property in international financial markets , means that most countries tend to establish financial relationships with top-ranking international financial centres ,and a handful of international financial centres often play the role of financial intermediaries , makes financial resources flow smoothly across countries . This trend may beinterpreted as a result of the scale effect and the efficiency of information processing by gradually gather , finally led to the emergence of financial centers .

3.5. node strength and GDP

whether the agglomeration of financial resources has intrinsic impetus ? region's economy Total is the key factor determining financial agglomeration ? Tobin on 1955year The first time the introduced monetary factors into the traditional theory of economic growth , this Many scholars try to pass the theory of financial liberalization ,endogenous growth theory etc. Many theories to explain the long-term growth of the economy and the development of the financial sector whether there is a close relationship between flat . Financial Market capital flows for a region level can be seen as an important indicator of financial development levels , so this article Greek look through all regions GDP vs. Financial capital Flow Total , Verifying close relationship between financial development and economic growth , more The High level of economic development effectively drives the international financial Center's shape into . calculated , two nonlinear homogeneous relationships , correlation Factor to 0.712. Although most of the GDP is proportional to the Total amount of circulation Department , but Caimas, Is. , Luxembourg , Several special nodes in Hong Kong, China , because of the tax policy , history reason , Impact of factors such as geographic location , Although GDP Total is smaller , but remains an important financial center worldwide .

Research results on the one hand verify that the greenwooc(1990) etc People's research Investigate conclusions : High income level supports full development of the financial system , and Mature The financial system of the, in turn, provides impetus for further economic growth Force ; Low income level underdeveloped traps make the financial system hard to get. Show , This in turn hinders the allocation of resources to investment . on the other hand , research The also illustrates from the side the formation of financial centres and the accumulation of financial resources.

3.6. Clustering factor for financial market investment networks

Whether financial investment has regional flow laws ? because The number of clustering reflects the local topological nature of the network , in particular the network culture's connection connection features , This article then studies the clustering coefficients for the network . Clustering factor The picture the group structure characteristics of financial networks , defines nodes I Clustering Factor Ci for this ki the number of sides that actually exist between nodes Ei and the maximum possible edge number FC* k"1"/2] than , calculates the formula as follows :

According to the diagram 9 to see , except for individual nodes , Most nodes of the network has very high clustering coefficients , average clustering factor reached 0.842. when threshold value investment mean 50% when , Total [ ] node's cluster factor up to to maximum 1, that is, between each contiguous node of these nodes is in thefull connection state . This indicates that the international financial Network presents a distinct group structural features , Although most area nodes are not highly efficient ,but locally The area exists with several _ Regional financial Centers , through financial market The surrounding countries are closely interconnected with each other .

in these tightly connected areas , a node with a greater degree of connectivity includes the China Hong Kong , Canada , France , Germany , Japan , them or as financingFinancial center , or as an investment financial center , plays a role in regional finance heart roles . Step further , This article on clustering coefficients and node strength The correlation factor analysis , There is a weak negative correlation between the two , correlation Factor = -0.24. The result indicates that A country with a small investment in,, typically does not choose To establish an investment relationship with an international financial center outside of the region , and tend to Connect with neighboring countries in the region , Form A localized Cluster Group , Regional financial centers are responsible for these regional clustering groups to connect to external regions .

3.7. Foreign financial Market Investment network and Cross-border use of RMB

In terms of the flow of investment funds , Simple financial center into type ;Fundraising type) Financial Center and outward-oriented investment Financial center . differs from The role of the type of financial center in

the surrounding area is also different . The study of the before the is based on a stateless network , the cannot differentiate between areas of Attraction and the difference in foreign investment . for a more accurate analysis of the financial central role in the zone , This article is followed by a network to Understand the differences in the flow of funds between nodes .

First , Cumulative amount of external investment absorbed by each node Cloth Data Fitting , the result proves that the distribution is also a power law distribution . fitting equation to f x^d^x ^, where a =0.0021 (a less reason is Select unit issues , The confidence interval for is (0.0008, 0.0041); b =0.404, confidence interval is (0.338,0.471). R square statistic is 0.829 , fitting results are better . fit results prove , Investment funds focused on net A handful of nodes in the network , over 60% Total for the region of and less than the total absorption of the United States market , the second-ranked UK absorbed to less than half of the United States . from the regional financial market View , Europe's financial markets are much more developed than others. , Caimas, Is., Method Country , Germany , Luxembourg , traditional financial centres such as the Netherlands and the UK are absorbed into the The investment funds for the are more than 2 trillion U.S. dollars. in Asian financial markets , saying Ben and China :Continental Financial markets are most capable of attracting foreign investment , But the two and also only 2.42 trillion dollar . Although Asia includes China , India , South Korea etc emerging economies , But financial market maturity and openness are more than the European market is backward , directly affects the attractiveness of foreign investment .

Second , to fit the cumulative distribution of each node's total outward investment , Capital distribution of outward investment still subject to power law distribution ,cumulative distribution fitting equation to f x)= a*x " b , where a =0.021, and The probability of falls on the interval (0.012,0.03) ; b =0.253,95% The probability of falls in the interval The (0.221, 0.285) . R by square statistics 0.891, Proof fit result better .

and the power value of the absorbed capital distribution 0.404 compared to , Foreign Investment cloth power 0.253) smaller , describes the imbalance in the distribution of outbound investment capabilities more unbalanced than absorbing funds . in the area of the statistics, in the same box. Foreign investment highest ten Region accounts for the global total external investment of 80%. A large part of the country's foreign financial investment ability is very weak , only very few The areas of have strong external investment capabilities .

It is worth noting that , Hong Kong, China as GDP A smaller total of Zone , not only have a high ability to attract foreign investment throughout the year , and has a veryStrong outbound investment . 2014 first half of China Hong Kong foreign financial market the total investment in the farm reached 1.15 trillion dollar , exceeds Singapore ,plus hold large financial powers , second only to Japan in Asia . in contrast to , because of the China adopts progressive open capital market policy , Financial Investment subject to suppress , smaller , is the lowest capital mobility in all Asian emerging countries in countries [9] . booming of Hong Kong RMB Offshore Financial center , not only short Capital opening for mainland China , Long term can be directly pushed Move financial deepening of mainland China , Important for RMB internationalization semantic . 2014 year all monthly Shanghai Tong " officially run , " for foreign investment into China Add new channel , Marks the integration of the capital markets of both places gradually strengthened .

4. Conclusion and policy recommendations

4.1. Conclusion

Although the level of global financial integration is steadily increasing , But the financial market The Resource distribution of the field network still has a large imbalance ,Network Rich Club Music Department "" more obvious , Several important financial centres Master Most of the financial resources , Network Rich Club music Department ""is relatively clear show .

The United States and Britain are the most important nodes in the international financial Network , Asia Financial markets are more developed and developed than European financial markets. many . China Hong Kong is the most important regional finance in Asian financial markets Heart , has strong ability to attract foreign

investment and ability to invest abroad , The assumes a take responsibility for the entire Asian financial market .

There is a certain number between the economic aggregates of a region and the level of financial development Positive relations ; Financial Market Network has a more obvious homogeneity , Big some countries tend to prioritize financial relationships , The financial agglomeration model led to the emergence and growth of financial centres.

The group structure of the International financial Investment Network is more obvious , Investment A small number of countries tend to be close to each other in the region. Connect , to form a local cluster group , Regional Financial Center The connection between these regional clusters and external regions is .

4.2. policy recommendations

Multiple reasons, such as policy restrictions , Financial markets in mainland China before the development phase , on the one hand, the need to vigorously promote financial reform and gold Merge drill , on the other hand, we need to take advantage of Hong Kong's open and healthy Investment environment , Strengthen contact with international financial Markets , promote RMB promote economic growth across borders .

Pan Yingli ; 2003) for , as the city of International Financial center The conditions that are required for include : hinterland or surrounding area with high economic growth 's huge financial services demand as Gravity [a] . China is the world's development null one of the largest economies , has a huge external capital flow requirement ,as a financial transshipment port between mainland China and other countries of the world , in People's currency fully convertible before , Hong Kong, China will always be the ideal offshore gold Center . Hong Kong, China with the support of the central government to actively develop Asia money Market : is mainly Asian dollar market and Asian Euro market), do the Financial intermediation between mainland financiers and international investors . with China economic growth , with the gradual evolution of financial liberalization , China Hong Kong hopes to be a par for the United States New York , first Class international gold in London, England Thaw Center [one].

Barabas (1999) and other people's research that , The Scale-free network has a more High System stability , but weak against attacks , When important condolences Hub Node) When there is a crisis , Systemic risk is likely to spread across the network [ ]. Hong Kong, China as a systemically important node , to avoid once a financial crisis is issued spread to surrounding areas especially mainland China financial markets , protect China the stable and healthy operation of Hong Kong's stock market and bond markets is particularly critical . as two relatively independent and increasingly integrated financial system , must be heavy View Hong Kong and mainland China's financial regulatory cooperation and coordination . specifically , China People's Bank and Hong Kong Monetary authority to control financial risk , financial crisis test , identify , Enhanced collaboration and collaboration in areas such as early warning and rescue .

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