Research on Policies of Chinese Strategic Emerging Industries' Cultivation and Development

Yuanyuan Hou, Yun Liu, Yijie Cheng
School of Management and Economics, Beijing Institute of Technology, Beijing, China

Abstract--**Developing strategic emerging industries is not only the effective means of dealing with financial crisis and achieving economic transformation, but also the vital strategic decision of achieving economic layout and building innovation-oriented country during the Chinese Twelfth Five-Year Plan Period. The paper quantitatively analyzed Chinese policies of strategic emerging industries enacted by the State Council, ministries and local governments, and studied the impact of policy subjects' relation on policies formulation and implementation by drawing collaboration network of policy subjects. The results show that the numbers of environment-type and supply-type policy instrument are larger; integral structure optimizes and policy subjects' function improves, policy subjects with some nodes at the core establish stable cooperative relationship; there are problems of excessive convergence on the local governments' selections of strategic emerging industries.**

I. INTRODUCTION

Strategic emerging industries have the characteristics of wide market prospects, low resource consumption and high comprehensive benefits; they not only play an important supporting role in the current industrial structural adjustment, but also lead the future direction of economic and social sustainable development. Encountering the severe influence of international financial crisis, the major developed countries have increased innovation investment and accelerated emerging technologies' layout in order to take the lead out crisis and occupy commanding point in the new round of economic growth. Developing strategic emerging industries is not only the effective means of dealing with financial crisis and achieving economic transformation, but also the vital strategic decision of achieving economic layout and building innovation-oriented country during the Chinese Twelfth Five-Year Plan Period. Currently, there are wide gaps between China and developed countries in independent innovation capability of emerging industries; crucial techniques are severely lacking and standard system is imperfect in China; Chinese investment and financing system, market environment and mechanisms can't fully meet the requirement of emerging industries' rapid development. Therefore, in order to ensure the development of emerging industries, in recent years especially during the Chinese Twelfth Five-Year Plan Period, Chinese governments at all levels have proposed policy measures, strengthened macro guidance and overall planning, set clear objectives, priorities and directions. In Chinese central government level, *Twelfth Five-Year national strategic emerging industry development planning* and special industry planning of energy-saving and environmental protection, biotechnology, new materials, new energy vehicles, renewable energy and high-end equipment were released, forming a multi-level emerging industries planning system. In Chinese management system, governments established inter-ministerial joint conference of emerging industries. In aspects of Chinese specific policies, governments formulated policies and measures of intellectual property, access to new energy power station, and so on; pilot work such as carbon emission trading, tri-networks convergence, low-altitude airspace opening made important progress. In local government level, Beijing and other 23 provinces have released planning and implementation guidance of emerging industry development. The need for decision-making references of emerging industries' promotion policies is urgent.

Strategic emerging industries represent not only the direction of technological innovation and industrial development, but also the integration of emerging technologies and emerging industries. Accelerating the cultivation and development of emerging industries is major strategic decision of maintaining stable economic growth and promoting economic structural adjustments. Governments play a guiding and supporting role in emerging industries' cultivation and development. Reference [1-2] verified the significant effect of financial policy on emerging industries' development. Different policy orientations would affect development paths of emerging industries, as in [3]. Therefore, the paper strived to analyze Chinese strategies and policies of emerging industries, summarized current policy direction, studied objectively problems and challenges in the process of industrial development, further discussed future policy trend, and provided references for Chinese governments to effectively guide and support industries' development.

Currently researches on the development laws and promotion policies of strategic emerging industries have become hot research areas in academic and political circles. Reference [6] compared the different emphases on emerging industries' layout and supporting policies of major developed countries. In addition, scholars have carried out research on status and problems of Chinese emerging industries' supporting policies. Reference [16] pointed out during the crucial turning point from introduction period to expansion period of the fifth technological revolution, Chinese policy orientations of cultivating emerging industries are to grasp inherent requirements and trends of new techno-economic paradigm, establish open innovation networks with Chinese characteristics, implement innovation strategies of industrial organization and system mechanism, and build the system of industrial capital leading financial capital. In local government level, there are problems of excessive

convergence on the selections of emerging industries, as in [7]. On the basis of status analysis, scholars put forward the framework design of promotion policies system of strategic emerging industries. A double helix model was proposed and the diamond model of emerging industries' policy system was derived, as in [6]. Reference [5] designed financial policies of fostering emerging industries from direct and indirect financial level.

In conclusion, there are multiple studies on effect of emerging industries' policies from a theoretical perspective, based on the results frameworks of promotion policies are proposed, but less empirical researches on policy system are done, policy subjects as the important factors in policy formulation and implementation are less involved. However, the underlying reasons of policy discourse's unbalanced distribution are institutional path dependence and sectoral benefit dispute in the process of national economic and political system reform; synergy of innovation goal orientations in different government departments shows significant stage characteristic, as in [9]. Reference [12] pointed out that with the transformation of innovation strategy, Chinese innovation policies were breaking away from single-agency formulation mode, policies of multi-agency formulation mode were increasing, and innovation policies were more systemic and consistent. Relations between policy subjects directly affect policy formulation and implementation. Therefore, the paper quantitatively analyzed policies of emerging industries enacted by the State Council, ministries and local governments, and studied policy subjects' cooperation and synergy by drawing cooperative network. It has important theoretical and practical significance in finding problems of policy system and forecasting policies' trend.

II. THEORETICAL SUMMARY

The related theories of the paper include Externality theory of governments, New Institutional Economics theory and emerging industry protection theory. Externality theory believes that governments intervene in markets because of the presence of catching-up strategy, as in [14]. Due to the enhancement of technical capacity in a region has a strong external economic effect, market coordination mechanisms are often paralyzed, namely market failure. Therefore, governments should intervene, support technology innovation and expand social welfare by increasing public utilities and infrastructure investment. New Institutional Economics theory believes that system innovation determines technology innovation, the reasons of economic growth only can be found from the institutional factors triggering the phenomena, as in [13]. Governments' guidance and support play significant roles in the industries' development, especially emerging industries' development. Due to emerging industries have the characteristics of public goods and externality, governments' role is more important. The emerging industry protection theory refers to the measures to nurture the international competition of infant emerging industries and reduce competitive threat. In the development of emerging industries, Governments provide policy guidance and services, regulate markets. From the aspects of policies' content, policies mainly involve as follows: (1) economic regulation areas: fiscal policies, investment and financing policies, tax incentives, property rights policies; (2) public service area: talents attraction and incentive policies; (3) social management areas: service policies of constructing, managing, operating and optimizing.

III. CHINESE STRATEGIC EMERGING INDUSTRIES' POLICIES ENACTED BY THE STATE COUNCIL AND MINISTRIES

Decision of the State Council on Accelerating the Cultivation and Development of Strategic Emerging Industries (2010) clearly proposed that energy conservation and environmental protection industry, new information technology industry, biological industry, high-end equipment manufacturing industry, new energy industry, new materials and new energy vehicles industry were the significant directions and major tasks of Chinese strategic emerging industries' development. *Proposal for National Economic and Social Development Twelfth Five-Year Plan* (2012) claimed to accelerate the seven industries to leading and pillar industries, and improve effectively industries' core competitiveness and economic benefits. *National Strategic Emerging Industry Development Plan during the Twelfth Five-Year Plan Period* set goals and development roadmap of seven industries; which pointed out that until 2020, strategic emerging industries would strive to be the key driving force of national economic and social development; energy conservation and environmental protection industry, new information technology industry, biological industry and high-end equipment manufacturing industry would become pillar industries, new energy industry , new materials and new energy vehicles industry would become leading industries. In summary, from the perspective of policies' contents, strategic emerging industries' policies enacted by the State Council and ministries consist of six main parts, namely cultivating market, supporting technological innovation and industrial innovation, strengthening personnel introduction and training, increasing financial support, promoting international development and improving ancillary facilities.

Due to the *National Plan for Medium and Long term Scientific and Technological Development* was enacted in 2006, which proposed to focus on the development of 8 technical areas and 27 cutting- edge technologies, such as biology, information, new material, advanced manufacturing, advanced energy, marine, laser and aerospace. The formulation of *National Plan for Medium and Long term Scientific and Technological Development* is the preparation for follow-up emerging industries' policies. So the paper regards 2006-2012 as study period, studies the policy documents which are obtained from websites of the State

Council and its ministries. The policies' number of each year is shown in Fig.1. According to the different manifestations of policy instruments, policies can be divided into supply-type, environment-type and demand-type, as in [4, 8]. Supply-type policy instrument manifests as policies' impetus to scientific and technological activities, governments expand technology supply directly through the supply of talents, technologies, capitals and public services. Environment-type policy instrument manifests as policies' influence on scientific and technological activities, governments improve the environmental factors by the way of target planning, financial support, regulatory norms, property rights protection and tax preferences to promote innovation indirectly. Demand-type policy instrument involves government procurement, trade policy, user subsidies, demonstration, price guide and other measures, as in [10, 11, 15]. The policies' number of each type is shown in Fig.2. The number of environment-type policy instrument is largest, a total of 137. Then there are 89 supply-type policies and 45 demand-type polities. The phenomenon is related to development stage of strategic emerging industries. Because most of Chinese strategic emerging industries are still in the embryonic development stage, have the characteristics of uncertainty technological path, high innovation costs, inadequate infrastructure facilities, no-clear market demand, inadequate laws and regulations. Through the enactment of environment-type policies and supply-type policies, governments gather industrial elements and optimize industrial environment to promote the development of emerging industries.

Because policy subjects have direct impact on policies formulation and implementation, analyzing cooperative relationship between policy subjects is an essential ingredient of policy research and has significant meaning for grasping current status and evaluating implementation effect of policies. The paper used visualization techniques and structural indicators to analyze dynamic evolution of policy subjects' collaboration network during the period from 2006 to 2012. Since *Decision of the State Council on accelerating the cultivation and development of strategic emerging industrie*s was released in 2010，it firstly described the meaning and development emphases of strategic emerging industries and determined seven emerging industries as priorities. Therefore the paper takes it as the dividing line, the policy documents enacted by the State Council and ministries are divided into two phases: during the phase from 2006 to 2009, after the enactment of *Long-term Science and technology Development Plan (2006-2020)*, the State Council and ministries mainly issued related innovation policy; during

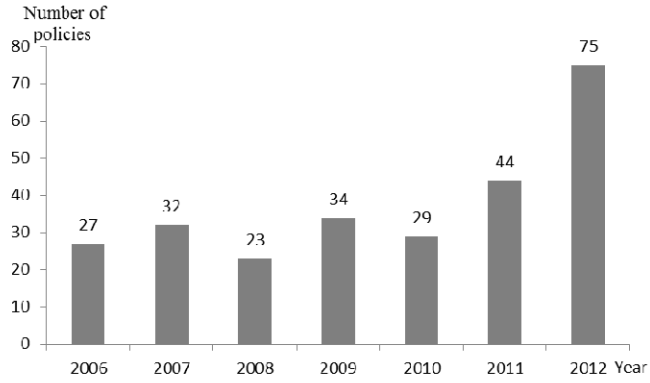

Fig.1 the number of emerging industries' policies enacted by the State Council and ministries each year (2006-2012)

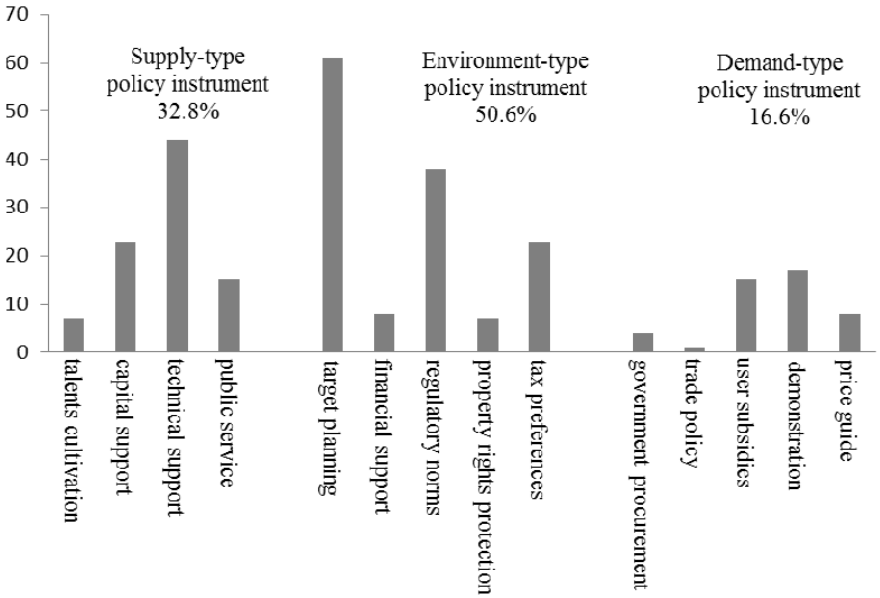

Fig.2 the number of emerging industries' policies enacted by the State Council and ministries each type (a total of policies from2006 to 2012)

the phase from 2010 to 2013, after the enactment of *Decision of the State Council on accelerating the cultivation and development of strategic emerging industries*, governments issued a series of industrial policies of the seven emerging industries. The collaboration networks of two phases are shown in Fig.3 and Fig.4. Among them, the network nodes represent policy subjects; the lines represent that two policy subjects (the two endpoints of the line) issue policies jointly. The larger the nodes are, the more policies enacted by the subjects are, the larger the degrees are. The thicker the lines are, the more policies the two subjects issue jointly, the higher the connection frequencies are.

To better understand the collaboration networks, network structural indicators are analyzed in the paper; the results are shown in Table 1. The number of samples indicates the number of policies issued in the phase; Network size indicates the number of subjects who issued policies in the phase; Network relation indicates the number of network connections between two subjects who issue policies jointly; Network connection frequency indicates the number of policies issued jointly; Cooperation intensity is defined as network connection frequency dividing by network size; Network cohesion index indicates the links' tightness between policy subjects.

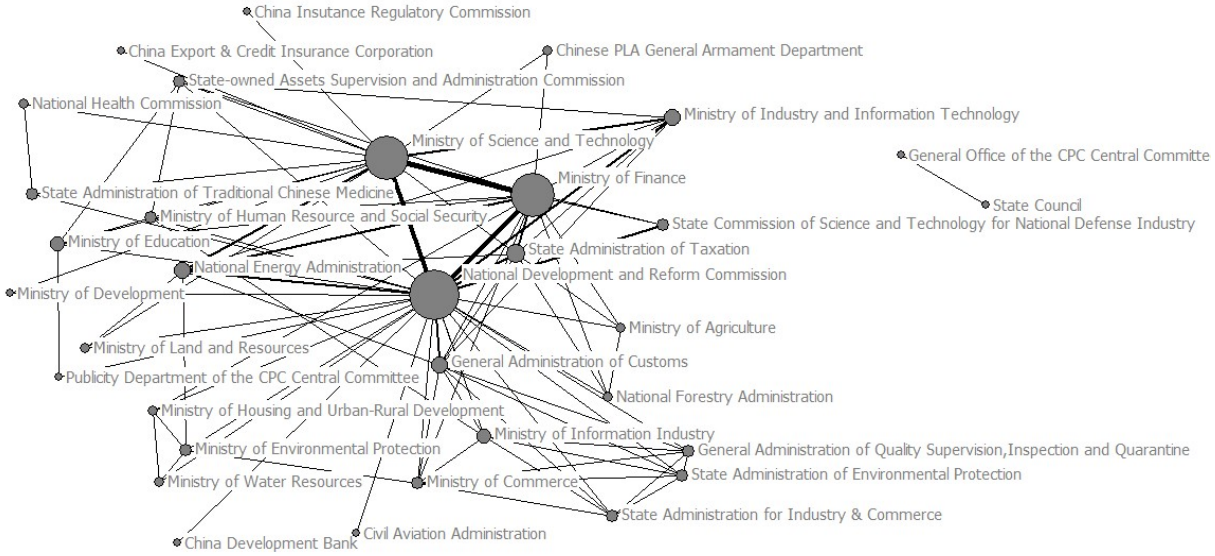

Fig.3 the policy subjects' collaboration network of policies enacted by the State Council and ministries during the phase from 2006 to 2009

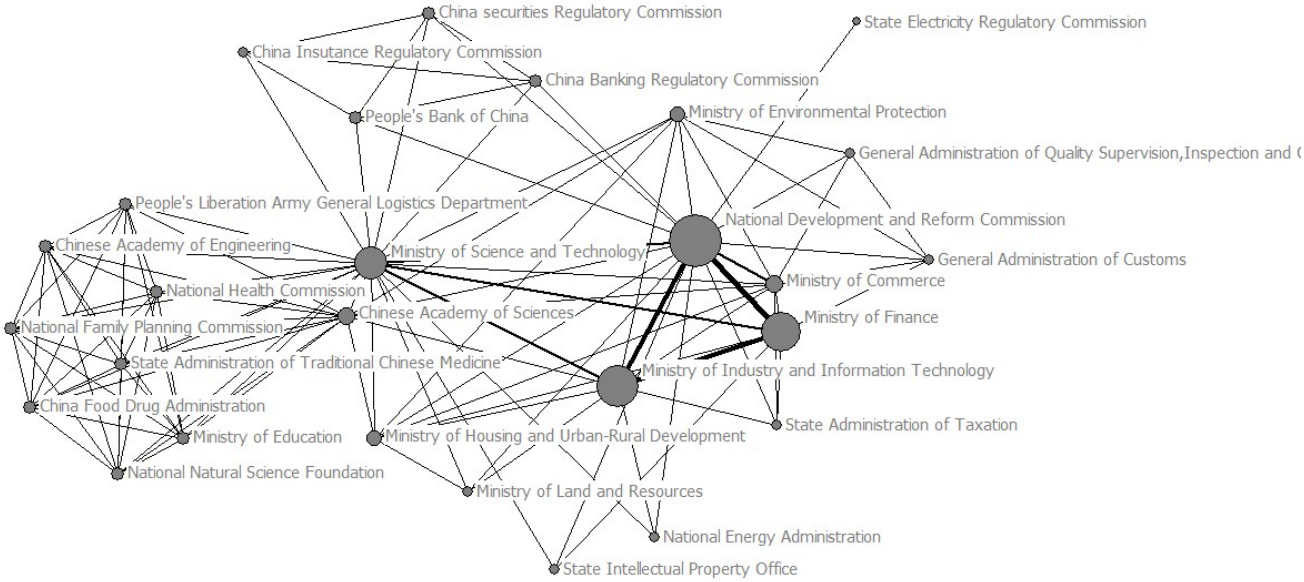

Fig.4 the policy subjects' collaboration network of policies enacted by the State Council and ministries during the phase from 2010 to 2012

During the phase from 2006 to 2009, as shown in Fig. 3, the State Council and ministries issued 116 policies, 49 of which are jointly issued, accounting for 42.2% of the total. The number of policies enacted by National Development and Reform Commission (NDRC), Ministry of Science and Technology (MST), Ministry of Finance (MF) is more. In the first phase, the number of a few nodes' connections is large; while most nodes' connections are few; network cohesion index is only 0.4370, it indicates that a small number of nodes in the network playing the dominant role in the network makes the network lack of stability and integral connectivity. The cooperation network of policy subjects in the phase presents network form of center- periphery type. During the phase from 2010 to 2012, as shown in Fig.4, the State Council and ministries issued 148 policies, 39 of which are jointly issued, accounting for 26.4% of the total. NDRC is the important node of the network, the number of policies co-issued by NDRC increases to 73, the number of cooperative subjects decreases to 18. In addition, the Ministry of Industry and Information Technology (MIIT) has also become a key node in the network. By analyzing structural indicators of two phases, the results show that the number of policy subjects reduces from 33 to 27; but the number of network relation increases from 190 to 218; Network connection frequency increases from 165 to 197; cooperation intensity increases from 5.00 rose to 7.30; network cohesion index increases from 0.4370 to 0.7537. It shows cooperation subjects are more stable, cooperation intensity and cohesion index are higher in the second phase, and policy subjects with some nodes at the core establish stable cooperative relationship, the cooperation network of policy subjects in the phase presents network form of entirety- coordination type. Moreover, compared with the 2006-2009 phase, two sub-graphs with relatively clear boundaries have formed in the 2010-2012 phase, as shown in Fig.4; relationships between subjects in the sub- graphs are closer.

To further analyze the evolution of policy subjects' role in the network, the paper establishes breadth- strength two-dimensional matrix. The degree of a subject is used to measure cooperation breadth, which is the number of other subjects issued policies with the subject. The connection frequency of a subject is used to measure cooperation strength, which is the number of policies issued jointly. The role of policy subjects may be divided into four types: (1) High breadth - high strength type (HH), it means more cooperation subjects and more policies; the subjects of the type are core nodes in the network. (2)High breadth - low strength type (HL), the subjects of the type are important nodes, cooperation scope is wide but cooperation sustainability is lack. (3)Low breadth - high strength type (LH), the subjects of the type are general nodes, cooperation subjects are limited but cooperation sustainability is strong. (4) Low breadth - low strength (LL); the subjects of the type are edge nodes and play relatively minor roles in the network. Policy subjects' positions of two phases are shown in Fig.5 and Fig.6. In the first stage, National Development and Reform Commission (NDRC), Ministry of Science and Technology (MST), Ministry of Finance (MF) are located in the HH quadrant, cooperation strength are higher than cooperation breadth, it indicates that the roles of NDRC,

TABLE1 NETWORK STRUCTURAL INDICATORS OF POLICIES ENACTED BY THE STATE COUNCIL AND MINISTRIES

structural indicators	phase of 2006 -2009	phase of 2010-2012
Samples' number	116	148
Network size	33	27
Network relation	190	218
Network connection frequency	165	197
Cooperation intensity	5.00	7.30
Network cohesion index	0.4370	0.7537

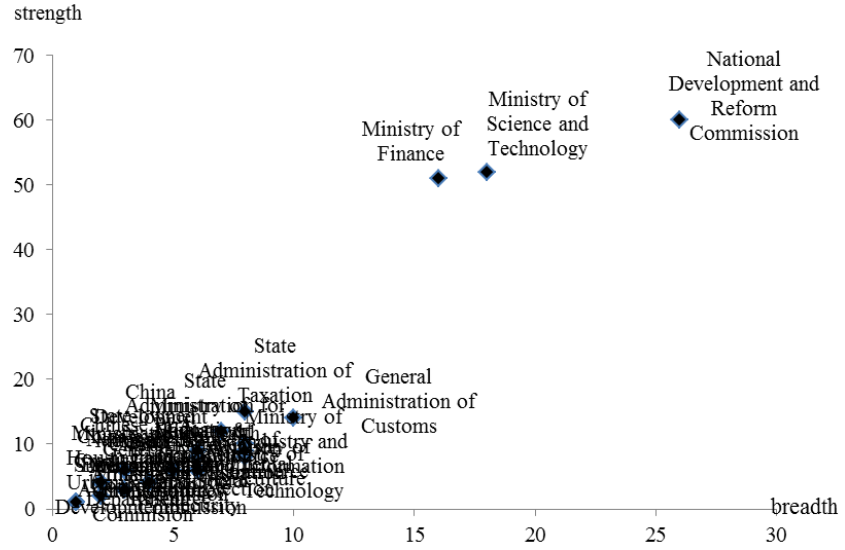

Fig.5 the position of policy subjects in the collaboration network during phase from 2006 to 2009

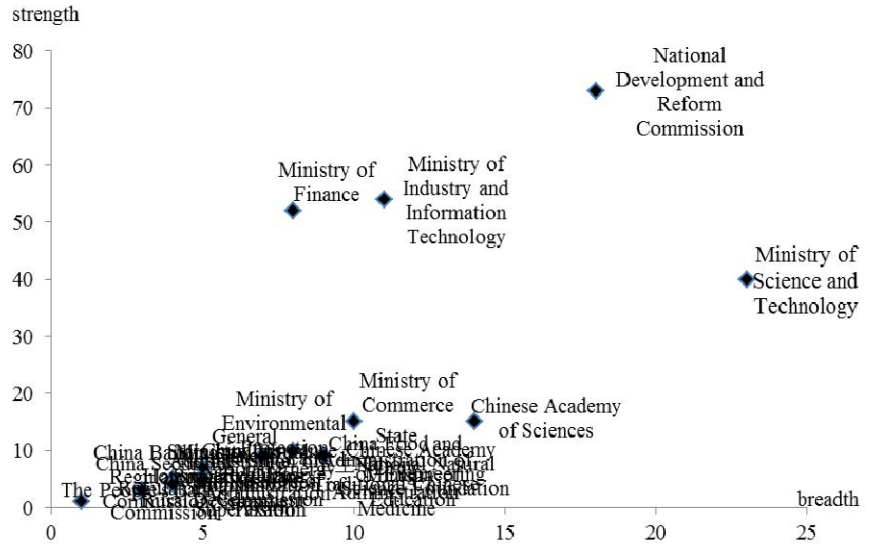

Fig.6 the position of policy subjects in the collaboration network during phase from 2010 to 2012

MST, MF become from policy leaders to policy coordinators gradually. The General Administration of Customs is located in the HL quadrant; State Administration of Taxation is located in the LH quadrant; other subjects are located in the LL quadrant. In the second stage, NDRC, MST are located in the HH quadrant, cooperation breadth of MST extends; the number of subjects cooperating with MST increases, this indicates that policy functions of technology management departments have enhanced, the status of MST in policy formulation and supervision have enhanced. Cooperation strength of NDRC improves, cooperation stability enhances. MF, Ministry of Industry and Information Technology (MIIT) are located in the LH quadrant, position's evolution of MF manifests as enhancement of cooperation strength but not extension of cooperation breadth, it means the transformation of policy emphasis from overall supporting number to key aspects' supporting strength. MIIT increases from LL to LH; cooperation breadth and strength both increase. Chinese Academy of Sciences is located in the HL quadrant; other subjects are located in the LL quadrant. In summary, the reformation of MST and NDRC promotes the specialization of departmental functions and plays a significant role in the operation of policy subjects' cooperation network.

IV. CHINESE STRATEGIC EMERGING INDUSTRIES' POLICIES ENACTED BY LOCAL GOVERNMENTS

Because different provinces' geographical advantages such as innovation elements, human capital, regional innovation capacity, industrial clusters and market demand are different, local government identified different strategic emerging industries as development emphases. Heilongjiang Province identifies new materials, new energy, new environmental protection, biology, information technology, modern equipment manufacturing as strategic emerging industries; Beijing identifies and refines development direction of eight strategic emerging industries involving new information technology, biomedicine, new energy, environmental protection, new energy vehicles, new materials, high-end equipment manufacturing and aerospace. The paper analyzes emerging industries' development emphases of 29 provinces except Tibet, Hainan, Hong Kong, Macau and Taiwan, the results are shown in Fig.7. 28 provinces take new energy and new materials as key industries.25 provinces foster new information technology industry; 24 provinces develop biomedicine industry; 22 provinces foster high-end equipment manufacturing industry; and 21 provinces develop energy conservation industry. In conclusion, there are problems on the local governments' selections of strategic emerging industries, mainly reflected in two aspects: from the perspective of own region, industry selection is not mature enough; from the perspective of regions' relation, the industry choice is excessive convergence.

To accelerate the development of strategic emerging industries, local governments formulate a series of policies; from the aspects of content, policies involving formulating special financial policies and fiscal policies, building multi-level investment and financing systems, strengthening the construction of innovation platform, implementing major demonstration projects, strengthening market cultivation and promoting open innovation cluster. The paper analyzes policies and measures of 29 provinces, as shown in Fig.8. 16 provinces set up special financial funds; 22 provinces increase fiscal support; 24 provinces formulate investment and financing policies; 25 provinces strengthen personnel training and introduction; 26 provinces strengthen the construction of innovation base and platform; 22 provinces implement major demonstration projects; 21 provinces strengthen market cultivation; 20 provinces promote international development of emerging industries. This shows that policies and measures of local government fostering strategic emerging industries have a high degree of consistency.

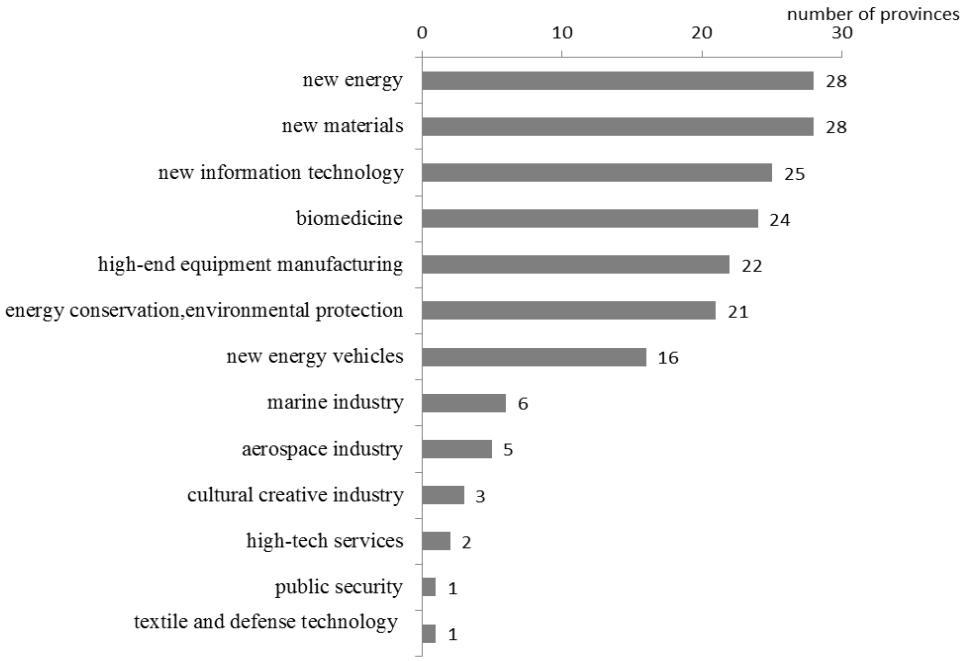

Fig.7strategic emerging industries identified by local governments during the Twelfth Five-Year Plan Period (29 provinces in all)

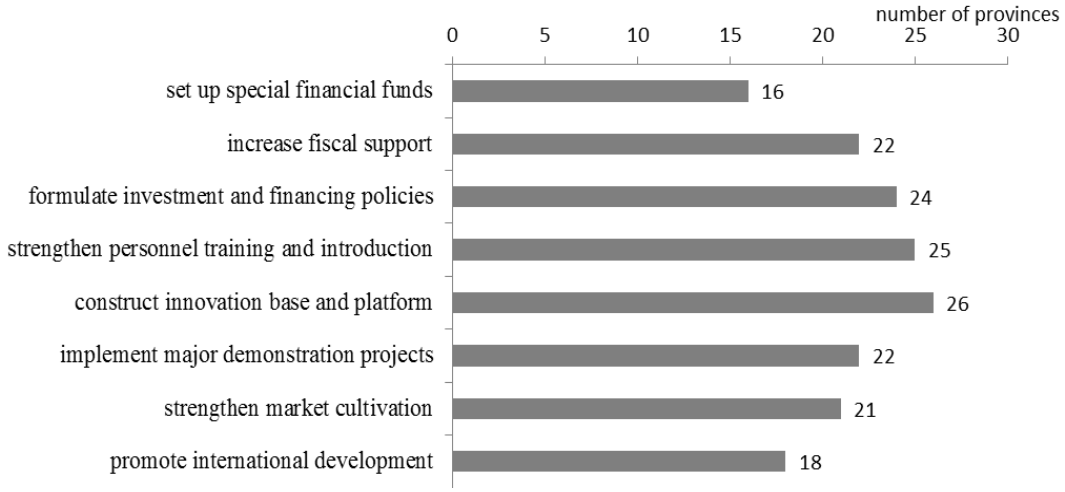

Fig.8 policies' emphasis of local government fostering strategic emerging industries (29 provinces)

V. CONCLUSION

By analyzing policies of strategic emerging industries enacted by the State Council, ministries and local governments, the characteristics are summarized as follows.(1) Because characteristics and development stages of different emerging industries are different, policy instruments fostering emerging industries are not entirely consistent. Among the strategic emerging industries' policies enacted by the State Council and ministries, the numbers of environment-type policy instrument and supply-type policy instrument are larger; because Chinese strategic emerging industries are still in the embryonic development stage. (2)In the policy subjects' collaboration network of policies enacted by the State Council and ministries, integral structure optimizes and policy subjects' function improves. Compared with the first stage, the number of policy subjects decreases, but the number of co-issued policies increases. It indicates that policy subjects with some nodes at the core establish stable cooperative relationship. The core subjects such as MST, NDRC and MF clear the functional orientation in accordance with the overall objective of emerging industries' development, subjects' functional improvements contribute to the overall optimization of network structure to some extent.(3) The industries identified by local governments are excessive convergence, and policy measures to foster

emerging industries have a high degree of consistency, it reflects the immaturity in the selection of emerging industries and policy instruments.

However, in the establishment of innovation ecosystem of emerging industries, there are still some problems restricting emerging industries' development. (1) The lack of advanced elements such as core technologies and high-level talents leads to the results that some fields of emerging industries depend on imitation innovation and incremental innovation; core technologies, equipment and parts depend on imports; the industries are in the low-end value chain with significant gap with foreign advanced level, such as chip production equipment and medical apparatus of China. (2) The lack of market demand. During the introduction period to market, emerging industries are facing with the restriction of marketization bottleneck. Due to initial market demand of some fields is lack or unclear, market promotion is facing with numerous obstacles. (3) Lack of generic technology platform. Currently, the national macro policies of generic technologies remain unclear, the relevant bases and platforms are in a divergent state and disjointed with regional development. (4) Unbalanced development of emerging industry chains. The industry chains of some fields are not complete, mostly concentrated on middle and lower reaches, the capacity of production matching is insufficient, and momentum of agglomeration development has not yet formed. (5) Market access restrictions hampering industries' development; monopolies of infrastructure areas restrict emerging industries' development and so on.

Moreover, there are still outstanding problems in the policy formulation and implementation of emerging industries. (1) Some backward mechanism stereotypes seriously hinder the development of emerging industries. For example, innovation drugs are not separated from traditional drugs in the medicine catalogue, drug approval policy is imperfect and approval cycle is .too long. (2) Tax incentives don't play their due roles, such as constraints of deduction policies are overmuch, eligible enterprises are few; the tax authorities only recognize project R&D spending approved by science and technology departments. (3) Blind investment leads to low level redundant construction. Some regions promote emerging industries equivalent to general industries, or regard emerging industries as a means of GDP growth. In the absence of core technologies, governments use administrative means of funding projects and enterprises, attracting investment by preferential measures of lands and loans. The excessive intervention leads to industrial sprawl and excess capacity. (4) Although policy subjects issue policies jointly, there are problems of information asymmetry, lack of efficiency, lack of coordination between governments and enterprises; the problems result in ineffectiveness of policy implementation.

Based on analyzing current situation and problems of emerging industries' policies, the paper puts forward policy suggestions as follows. (1) Governments should select scientifically key industries and priorities, adjusting measures to local conditions. (2) Coordination of government guidance and market regulation should be formed. (3) Positive interaction of emerging industries' development and traditional industries' upgrade should be formed. (4) The market demand of emerging industries should be cultivated. (5)According to the different characteristics and development stages of different industries, different policy instruments should be adopted. (6) The introduction and cultivation of high-level talents should be strengthened; the construction of generic technology platform should be strengthened.

ACKNOWLEDGMENTS

This work was supported by the Key Project of National Science Foundation of China (71033001) and .the General Project of National Science Foundation of China (71273030)

REFERENCES

[1] Arestis, Philip and Panicos Demetriades; "Financial development and economic growth: Assessing the evidence," *Economics Journal*, vol. 107, pp. 783-799, 1997.

[2] Beck, Thorsten, Ross Levine and Norman Loayza; "Finance and the sources of growth," *Journal of Financial Economics*, vol. 58, pp.261-300, 2000.

[3] Chen, Hongtao, Jin Chen, Fang Shi and Shenghua Zheng; "Research on mechanism of government function in the development of emerging industries- Based on theoretical model of national political institution frameworks," *Science Research Management*, vol. 30, pp. 1-8, 2009.

[4] Chinese academy of engineering science and technology development strategy; *Report on the development of China's strategic emerging industries*. Beijing: Science Press, 2013.

[5] Gu, Haifeng; "Study on finance supporting system and policy to strategic emerging industry evolution: Based on policy finance supporting perspective," *Science of Science and Management of S&T*, vol. 32, pp. 98-103, 2011.

[6] Li, Kui and Lijia Chen; "Research on Supporting Policy System for Strategic Emerging Industries Based on Double Helix Innovation Model," *China Soft Science Magazine*, vol. 12, pp. 179-186, 2012.

[7] Liu, Tie and Jiuyun Wang; "A study on excessive convergence in the choice of regional strategic emerging industries," *China Soft Science Magazine*, vol. 2, pp. 115-127, 2012.

[8] Nemet, Gregory F.; "Demand-pull, technology-push, and government-led incentives for non-incremental technical change," *Research Policy*, vol. 38, pp. 700-709, 2009.

[9] Peng, Jisheng, Wenxiang Sun and Weiguo Zhong; "The evolution of Chinese technological and innovational policies and the empirical research on the performance (1978-2006),".*Science Research Management*, vol. 29, pp. 134-150, 2008.

[10] Peters, Michael, Malte Schneider, Tobias Griesshaber and Volker H. Hoffman; "The impact of technology-push and demand-pull policies on technical change: does the locus of policies matter?," *Research Policy*, vol. 41, pp. 1296-1308, 2012.

[11] Stefano, Giada Di, Alfonso Gambardella and Gianmario Verona; "Technology push and demand pull perspectives in innovation studies: current findings and future research directions," *Research Policy*, vol. 41, pp. 1283-1295, 2012.

[12] Sun, Yutao and Cong Cao; "An empirical study in the cooperative structure evolution of China's innovation policymakers under the background of strategic scene change," *R&D Management*, vol. 24, pp.94-104, 2012.

[13] Wu, Jinqun and Yina Geng; "Nature of the government in the perspective of new institutional economic," *Jounal of Zhejiang University*, vol. 38, pp. 57-66, 2008.

[14] Zhang, Ganfeng; "Research on economic externalities," *Finance*

Economy, vol. 4, pp. 26-28, 2007.

[15] Zhao, Xiaoyuan and JunSu; "The analysis frame of public science technology policy based on the policy tool angle of view," *Studies in Science of Science*, vol.25, pp. 52-56, 2007.

[16] Zhu, Ruibo; "Chinese strategic emerging industries' cultivating and policy tropism," *Reform*, vol.3, pp.19-28, 2010.