

From Administrative Domination to Administrative Leadership: The Evolution of Food Safety Collaborative Regulation in China

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Project funding: National Social Science Fund Special Project(18VSJ031)

ABSTRACT

Using social network analysis, this paper draws on the collaboration networks of Chinese food safety regulation in different development stages, from 2004 to 2017, and examines the characteristics of the networks. We find that governmental organizations play a key role in food safety collaborative regulation and that its dominant role in the earlier stage is developing towards a more facilitating role, which helps coordinate diverse stakeholders and sustain food safety collaborative regulation networks. In terms of individual nodes, food safety authorities represented by the China Food and Drug Administration (CFDA) are the core actors. Indirect functional departments, such as the Ministry of Education and the Ministry of Public Security, are emerging key actors that contribute dynamics to the collaborative network. These findings help demonstrate the dynamics of inter-organizational relations in food safety regulation and generate important policy implications for policy design and implementation.

Keywords: food safety, central government, collaborative regulation, social network analysis, China

De la dominación administrativa al liderazgo administrativo: La evolución de la regulación colaborativa de seguridad alimentaria en China

RESUMEN

Utilizando el análisis de redes sociales, este documento se basa en las redes de colaboración de la regulación de seguridad alimentaria china en diferentes etapas de desarrollo, desde 2004 hasta 2017, y examina las características de las redes. Descubrimos que las organizaciones gubernamentales desempeñan un papel clave en la regulación colaborativa de seguridad alimentaria y que su papel dominante en la etapa anterior se está desarrollando hacia un papel más facilitador, que ayuda a coordinar diversas partes interesadas y mantener las redes de regulación colaborativa de seguridad alimentaria. En términos de nodos individuales, las autoridades de seguridad alimentaria representadas por la Administración de Drogas y Alimentos de China (CFDA) son los actores principales. Los departamentos funcionales indirectos, como el Ministerio de Educación y el Ministerio de Seguridad Pública, son actores clave emergentes que contribuyen a la dinámica de la red de colaboración. Estos hallazgos ayudan a demostrar la dinámica de las relaciones interorganizacionales en la regulación de la inocuidad de los alimentos y generan importantes implicaciones políticas para el diseño e implementación de políticas.

Palabras clave: inocuidad de los alimentos, gobierno central, regulación colaborativa, análisis de redes sociales, China

从行政主导到行政领导：中国食品安全合作监管的演变

摘要

通过社会网络分析，本文研究了2004年至2017年间中国食品安全监管合作网络的不同发展阶段，并检验了该网络的特征。我们发现政府机构在食品安全合作监管中发挥关键作用，并且政府机构在早期阶段中发挥的主导作用正过渡到更具促进性的作用，帮助协调不同利益攸关方并维护食品安全合作监管网络。就单个节点而言，国家食品药品监督管理总局（CFDA）所代表的食品安全权威机构是核心参与者。起间

接作用的部门，例如教育部与公安部，都是对该合作网络作出动态贡献的新兴关键参与者。这些研究发现帮助证明食品安全监管中机构间关系的动态，并为政策设计和执行提供重要的政策意义。

关键词：食品安全，中央政府，合作监管，社会网络分析，中国

Introduction

As the saying goes, “food is the basic of the people, safety is the basic of food.” Food safety concerns the national economy and people’s livelihoods, which not only directly affect the legitimacy of political achievements, but also the legitimacy of political power. Therefore, food safety has attracted much attention in recent years. The Third Plenary Session of the Eighteenth Communist Party of China (CPC) Central Committee proposed that food safety be an integral part of the public safety system. The thirteenth Five-Year Plan clearly emphasized that we must comply with the “Four Most Stringent” requirements to implement the Food Safety Law. The nineteenth National Congress of CPC further proposed that “the implementation of food safety strategies will allow people to eat with confidence.” All in all, the improvement of food safety governance has become a key issue in China’s national governance.

Despite the steady improvement of China’s food safety regulatory capabilities, there remain many drawbacks. Among them, the most criticized is the

lack of collaborative regulation (Ma 2015). On the one hand, the segmented regulation system leads to the fragmentation of authority (Liu 2010). As a result, achievement depends not only on individual departments’ efforts, but also on collective collaboration. On the other hand, food safety is a typical cross-boundary issue that transcends knowledge and jurisdictional boundaries. Consequently, the stakeholders involved are diverse. The political interests of the regulatory authorities, the economic interests of the regulated, and public social interests are intertwined, and thus, tensions arise. It is necessary to promote and facilitate regulatory collaboration, build mutual trust, and integrate multiple interests to improve regulatory effectiveness and resolve regulatory dilemmas.

In this context, the collaborative regulation of food safety has become a hot topic. Recent research has used holistic government, game theory, and relational contracts perspectives. The core of holistic government theory is coordination and integration. It advocates the elimination of the collective action dilemma through institutional integration and restructuring (Chen and

Zhang 2012). When it comes to meeting food safety challenges, in order to enhance interagency collaboration, we should change the organizational structures, establish new accountability and incentive mechanisms, build better partnerships, and reshape organizational cultures (Yan 2010). While the holistic government approach is promising, it may also be costly and fragile due to irreconcilable conflicts of interest, the complexity of new arrangements, obscure accountability mechanisms, and so on.

From the perspective of game theory, scholars analyze the factors affecting organizational cooperation or embarrassment by constructing a game model between regulatory agencies (Yuan and Hu 2014). Although sophisticated mathematical models can provide some useful insights, for the sake of simplification, they usually focus on games with exactly two players rather than multiple players to examine players' strategies. Therefore, it weakens the explanatory power of the model and the conclusions are likely to be discrepant from reality.

From the perspective of relationship contracts, collaborative regulation is regarded as a relationship contract between entities. The pursuit of autonomy by individual departments, the uncertainty of return, and the externality of governance effectiveness lead to higher transaction costs between departments, hindering collaboration. To address these challenges, we should redesign the authority configuration structure, nurture a fair and trust envi-

ronment, and reduce externalities. The construction of a departmental collaboration mechanism should also focus on the above aspects (Nie and Yan 2009; Yan and Nie 2009). Although this view is quite insightful, it regards the transaction subject as a pure economic man, follows the beaten track of under-socialized interpretations, and ignores the influence of interpersonal relationships embedded in the exchange.

In general, scholars have thoroughly explored the issue in terms of a causal mechanism for insufficient collaborative regulation, the ideal form, and designs of collaborative regulation. Regrettably, few studies have systematically explored the development of China's food safety collaborative regulation. To make up for this deficiency, this paper discusses the issue from the perspective of social network analysis (SNA). In essence, collaborative regulation is a cross-agency, cross-level, and cross-sector governance arrangement aimed at achieving specific goals via collective action. Otherwise, it is difficult to achieve the above goals by an individual department. This process places particular emphasis on deliberation and consensus. From this perspective, collaborative regulation can be regarded as a goal-oriented, multi-agent collaboration network. The action strategies adopted by actors are deeply constrained by the network structure or relationship structure in which they are embedded. Once it is removed, it is difficult to display the essence of cooperation. As a specialized network analysis tool, SNA provides a series of concepts and methods for exploring the struc-

ture of the network and the relationship between actors (nodes), such as density, centrality, and structural holes. It can quantitatively and completely describe the characteristics of collaborative regulation at whole-network, group, and actor levels. Given that, we intend to add to the growing body of knowledge the issue of China's food safety collaborative regulation by SNA.

Research Design

Theoretical perspective and the analytical dimension

In the past twenty years, the study of food safety collaborative regulation has become an important field of food safety research. The current literature falls into two categories based on the research foci. (1) Cross-sector collaborative regulation research focuses on the public-private partnership regulation model. The literature uses different concepts such as “management-based regulation,” “co-regulation,” and “meta-regulation” to name this model (Rouvière and Royer 2017, 135). Some scholars summarize the co-regulatory practices adopted by the UK and North America into the four key aspects of food safety regulation: setting standards, process implementation, enforcement, and compliance monitoring (Martinez et al. 2007). Rouvière and Royer (2017) offer new insights into these collaborations; they consider these arrangements as embedded meso-institutions, merging both public and private actors into a single institutional frame to respond to food

safety incidents. With the concept of social co-governance being emphasized as the basic principle for food safety governance in China, many Chinese researchers focus on the design of ideal social co-governance model supporting mechanisms. Ding and Sun (2014) identify several main tasks for those who wish to promote social co-governance: promoting the development of NGOs, improving the coordination of relevant actors, encouraging citizen participation, and integrating resources. Liu and Li (2018) introduce smart regulation theory to shed new light on food safety collaborative regulation. (2) Inter-government and intra-government collaborative regulation research: Freeman and Rossi (2012) assess the relative strengths and weaknesses of coordinative regulation frequently used in the US: interagency consultation, interagency agreements, joint policy-making, and presidential management of coordination. The Government Accountability Office (2012) put forward some key considerations requiring attention for effective implementation of interagency collaborative mechanisms: outcomes and accountability, bridging organizational cultures, leadership, clarity of roles and responsibilities, participants, resources, written guidance, and agreements. When it comes to improving food safety interagency collaboration in China, Liu (2010) advocates the establishment of a strong coordination body. Similarly, Ma (2015) emphasizes the importance of enhancing the authority of a comprehensive coordination body.

In a word, compared with their western counterparts, Chinese researchers overemphasize normative elaboration and relatively neglect the empirical study of food safety collaborative regulation. Therefore, there is an urgent need to promote related empirical research. Fortunately, SNA, a promising method for analyzing interaction pattern within social structures, offers opportunities to satisfy this need and provides new insights into food safety collaborative regulation in China.

SNA presents a set of qualitative, quantitative, descriptive, and inferential approaches to analyzing relational data (Kapucu, Hu, and Khosa 2017) and allows researchers to study these data from multiple levels of analysis: individual actors, substructures, and complete structures. As a result, it is a useful method for studying collaborative interactions. In the past few years, we have seen increasing application of SNA in public administration. Many scholars have successfully used it to investigate a lot of issues, including, but not limited to, public health service management (Milward et al. 2010; Provan and Huang 2012), emergency management (Kapucu 2006), natural resources management (Sayles and Baggio 2017), regional economic development (Lee, Feiock, and Lee 2012), and governance network performance (Yi 2018). Accordingly, the application of SNA will contribute to food safety collaborative regulation research.

Whole-network dimension

This paper uses network cohesion and network heterogeneity as indicators to

characterize whole-network properties. Generally speaking, the most commonly used indicator of cohesion is density. It describes the ratio of the actual number of connections in the network to the maximum number of connections that may exist (Liu 2004, 101–02). However, density is heavily constrained by the size of the network. Usually, the larger the network size is, the smaller the density. Therefore, we should be cautious when comparing networks of different sizes. By contrast, the average degree index is more advantageous (Nooy, Mrvar, and Batagelj 2014, 65). For collaborative regulatory networks, higher network cohesion means that the network actors interact more frequently, which helps to build trust and form common codes of conduct, and ultimately facilitates collective action. However, higher cohesion also has a dark side, leading to the homogeneity of communication, redundancy of information and resources, and a restriction in the participation of new actors, which are not conducive to the healthy development of collaboration (Oh, Chung, and Labianca 2004).

This paper uses cross-boundary exchange to measure network heterogeneity. Cross-boundary exchange describes the ratio of ties connecting actors with different affiliations to the number of total network connections (Sandström and Rova 2010). It reflects the strength of collaboration among heterogeneous groups in the network. For collaborative regulatory networks, higher network heterogeneity means that heterogeneous resources and knowledge exchange become more fre-

quent, which can promote complementary benefits and improve regulatory performance.

Group dimension

According to the types of issuing authority, the actors in the collaborative network are divided into different groups: administrative agencies,¹ CPC organizations,² public institutions,³ enterprises,⁴ and social organizations.⁵ This paper uses intra-group exchange and inter-group exchange as indicators to characterize the group properties. The former is the ratio of specific connections within a given group to the total connections in the network, while the latter is the ratio of connections of a given group to the total connections in the network (Olsson, Folke, and Berkes 2004). For collaborative regulatory networks, the larger the intra-group exchange is, the more central the group in the collaborative network; the larger the inter-group is, the more frequent the interaction between the given group and other groups, and the greater the possibility of heterogeneous actors participating in collective action, which is of great significance to the realization of collaborative governance.

Actor dimension

In the individual dimension, the degree centrality, weighted degree, and betweenness centrality are used to describe the status and role of the actor. The degree centrality describes the number of connections a node in the network has (Sharma and Surolia 2013), and is an important indicator to describe the influence of actors. As far as collaborative regulatory networks are concerned, the greater the degree of a given actor, the stronger the ability to communicate with others. The weighted degree further takes into account the weights of the connections between nodes. Higher weighted degree means that a given actor interacts more frequently with other actors. The status of actors is also closely related to their ability to control resource flows. Therefore, it is necessary to use the betweenness centrality to explain the status of the actor. It is the probability of an actor being on the shortest path between any pair of actors in the network (Nooy, Mrvar, and Batagelj 2014, 131). High betweenness centrality means that the node is able to control the interaction of other actors, so that it can take advantage of

1 The administrative agency is the executive organ of the state power organ.

2 The Party's organization is a unified organism organized by all Party members in accordance with its own program and articles of association and the principle of democratic centralism.

3 Public institutions are social service organizations organized by state organs or other organizations using state-owned assets for the purpose of social public welfare and are engaged in activities such as education, science and technology, culture, and health.

4 Enterprises generally refer to legal persons or other socioeconomic organizations that use various factors of production (land, labor, capital, technology, and entrepreneurship) to provide goods or services to the market for profit, and operate independently, bear their own profits and losses, and account independently.

5 Social organizations are non-profit social organizations formed voluntarily by citizens to carry out activities in accordance with their statutes in order to realize the common wishes of their members. Workers and young women are typical social groups.

its location to enjoy benefits. In addition, the indicator can identify actors who act as brokers or bridges among different groups. They can reconcile and mitigate conflicts and promote the flow of knowledge and resources among groups. Especially in the strongly connected network, it is more helpful to stimulate synergy and promote the vigorous development of collaborative governance (Long, Cunningham, and Braithwaite 2013).

The role of brokers can be divided into five categories: coordinator, itinerant broker, representative, gatekeeper, and liaison (Gould and Fernandez 1989). Specifically, when brokers and the nodes they connect to belong to group A, they act as intra-group coordinators; when brokers belong to group A and the nodes they connect to belong to group B, they act as outside-circle itinerant brokers; when initiators of the brokers and connections belong to group A and the recipients of the connections belong to group B, they act as representatives; and when brokers and recipients of the connections belong to group A and the relationship between them belongs to group A, they act as gatekeepers. When initiators belong to group B, they act as gatekeepers; when brokers belong to group A and the two nodes connected belong to group B and group C, they act as liaisons. Except for the intra-group coordinator, these roles coordinate the relationship between

different groups, which is of great significance for the maintenance and expansion of collaborative networks. It should be noted that since the collaborative network studied in this paper is an undirected network, the collaborative relationship can be regarded as a reciprocal relationship, and the spokesperson is equivalent to the gatekeeper.

Data sources and network construction

In order to conduct a systematic examination, this paper focuses on the formal cooperative relationship between food safety regulatory authorities. Generally speaking, there are different forms of inter-agency collaboration: joint mandate, joint law enforcement, and joint meetings. Considering the availability of data, this paper focuses on the joint mandate to characterize collaboration. We believe that the actors participating in the joint posting mandate form collaborative relations with each other. Based on this, we built a collaborative regulatory network.

Policies were collected from the Peking University Legal Information Database (PKULAW) database,⁶ which compiles public policies promulgated in Mainland China since 1949. We initially collected 628 policies issued during the period 2004–2017, using the keywords “food safety” in the dataset of “judicial interpretation of central regulations.”⁷ Then in order to ensure that the selected

6 The pkulaw.cn database was jointly launched in 1985 by the Legal Information Center of Peking University and Beida Yinghua Science and Technology Co. Ltd. It is currently the largest and most influential legal information retrieval database in China. It contains all the laws and regulations issued since 1949.

7 Due to the time limit of policy collection, the policies published before September 21, 2017 were collected.

policies are relevant to the research topics, the following principles were used to filter the collected policies: (1) the principle of relevance, that is, the content of the policies must be directly related to food safety regulation, and must be issued jointly by multiple departments; (2) the normative principle, that is, the selected policies must be official documents, such as laws, administrative regulations, or departmental rules. Informal documents, such as notes, were therefore excluded. A total of 576 policies were excluded based on these criteria. As a result, fifty-two policies related to food safety collaborative regulation issued during 2004–2017 were ultimately obtained.

It is worth noting that this time-span happens to be a period in which food safety collaborative regulation has been gradually gaining importance. In 2003, the newly established State Food and Drug Administration (SFDA) was entrusted with the responsibility of the comprehensive coordination of food safety administration. However, constrained by its administrative level, the agency is unable to control other departments and the coordination function has not been performed smoothly for a long time. To improve this situation, the Food Safety Committee of the State Council, headed by top-ranked officials such as the Vice Premier of the State Council, was established in 2010 to effectively encourage deliberations and strengthen coordination of food safety work. In 2011, the committee took on the comprehensive coordination function that had previously been assumed by the Ministry of Health. So far, sub-

stantial breakthroughs have been made in the comprehensive coordination of food safety regulation. In view of this, this paper takes 2011 as the cut-off point, assimilates the policy texts issued during 2004–2010 and those issued during 2011–2017, and compares the characteristics of collaborative regulatory networks in different periods.

In terms of the collaborative regulation network, the issuing agency is chosen as the network node, the joint issuing relationship between the entities is recorded as a link in the network, and the frequency of collaboration is recorded as the connection weight. It should be pointed out that the combination of agency A and agency B is equivalent to the joint publication of B and A. Therefore, a collaborative regulation network is an undirected network.

Research Findings

Based on the above indicators, this paper examines China's food safety collaborative regulation network from the whole-network, group, and actor dimensions in 2004–2017. This section reports on the results of social network analysis: firstly, it compares the whole-network attributes of collaborative networks in different periods; secondly, it explores the status of groups in the network; and finally, it analyzes the central actors in the network.

The whole-network characteristics of different periods

Table 1 gives a detailed overview of the whole-network characteristics of the

Table 1. The overall characteristics of cooperative network from 2004 to 2017

Period	Group Type	Group Size	Network Size	Connections	Average Degree	Cross-boundary Exchange
2004-2010	Administration Agency	14	15	132	8.8	4.55%
	CPC Organization	0				
	Public Institution	1				
	Enterprise	0				
	Social Organization	0				
2011-2017	Administration Agency	21	29	386	26.62	21.24%
	CPC Organization	3				
	Public Institution	1				
	Enterprise	1				
	Social Organization	3				

Source: The author's dataset.

network at different stages. For 2004–2010, the network consisted of fifteen nodes, which can be divided into three categories: administrative agencies, public institutions and enterprises. Among them, there were as many as fourteen administrative agencies and only one public institution. The number of connections in the network is 132. From 2011 to 2017, the number of nodes in the network increased to twenty-nine. Participants were also more diverse: in addition to the original two types of subjects, there were also new party organizations, enterprises, and social organizations. As the number of nodes increased, the num-

ber of network connections also increased to 386.

In terms of network cohesion, the average degree was 8.8 for 2004–2010 and 26.82 for 2011–2017. The enlargement of network size did not inhibit communication among the nodes, and the actors were in closer contact, which means that the collaborative network became more stable. This is due to the deepening of the central government's understanding of the necessity of collaborative regulation: in 2003, the comprehensive coordination of food safety regulation was emphasized, and the function was entrusted to the China Food and Drug Administration (CF-

DA)⁸; the eleventh Five-Year Plan proposed that the “overall consideration, integration of resources” should be incorporated into the basic principles of food safety regulation, and efforts were made to build a collaborative operation and co-management regulation mechanism; in 2010, the establishment of the Food Safety Commission (FSC) further highlighted the importance of comprehensive coordination. Subsequently, the central government proposed the establishment of a unified and authoritative food safety regulation system. All of these have promoted the development of collaborative regulation.

In terms of network heterogeneity, for 2004–2010, cross-boundary exchange was only 4.55 percent; for 2011–2017, it jumped to 21.24 percent, which indicates that the interaction between heterogeneous groups in the network increased significantly. The reason is that the concept of co-governance was given greater attention in food safety regulation. In fact, emphasizing the participation of stakeholders outside government departments has always been one of the traditional means of food safety regulation, such as the consumer complaints hotline, industry self-regulation and so on. However, it was not until the implementation of the newly revised Food Safety Law in 2015 that it was formally taken as the basic principle of regulation and guaranteed by law. There are great differences in the resources and knowledge of hetero-

geneous actors, and mutual exchange can promote non-redundant knowledge transfer. At the same time, high network cohesion accelerates the flow of resources, helps to play a synergistic role, and promotes the healthy evolution of collaborative networks.

Group characteristics of different periods

Table 2 illustrates group characteristics. The proportion of intra-cluster communication among administrative agencies was as high as 95.45 percent for 2004–2010. Since the size of the public institutions involved is 1, it does not constitute the basic condition for intra-group. For 2011–2017, although the interaction within the administrative agencies still dominates, the proportion dropped to 77.98 percent. The exchange among other groups is still limited: the intra-group exchange within CPC’s institutions, public institutions, and enterprises is absent, and social organizations is 0.78 percent. The above data show that administrative agencies are the central group of collaborative networks.

Actor characteristics of different networks

In order to more intuitively illustrate the status of each actor, we used Net-Draw 2.0 software to draw collaborative networks in different periods. Tie width is indicative of contact frequency among them, with wider ties indicating

8 Since the reform and opening, China has undergone several administrative restructuring reforms. Relevant organizations may undergo several renaming, revocation, reorganization or merger. This part adopts the names of the organizations at that time. At the same time, for the convenience of wording, the abbreviation of mechanism will be used in this paper.

Table 3. The centrality of supervisory subject 2004-2010

Regulatory Agency	Weighted Degree	Degree Centrality	Betweenness Centrality
SFDA	45	14	0.43791209
MOH	41	11	0.04230769
GAQSIQ	39	11	0.04230769
MOA	31	10	0.02124542
MOC	31	10	0.02124542
SAIC	31	9	0.01739927
MIIT	10	6	0
GACC	8	7	0
MPS	7	7	0
NDRC	6	6	0
SAC	6	6	0
MOR	4	4	0
MOE	2	1	0
MOHURD	2	1	0
CNTA	1	1	0

Source: The author's dataset.

more frequent contact; node size is indicative of the node's degree centrality, with larger nodes indicating more degree centrality⁹; and node shape is related to the type of node.

For 2004–2010, the most influential actors in the collaborative network are affiliated with the administrative agencies: the SFDA, the Ministry of Health (MOH), the General Administration of Quality Supervision, Inspection and Quarantine (GAQSIQ), the Ministry of Agriculture (MOA), the Ministry of Commerce, and the State

Administration of Industry and Commerce (SAIC). They not only actively build close collaborative relationship with other actors, but they also control the flow of information and resources in the network (see Table 3). In addition, Figure 1 shows that these actors are closely related to each other and form the core group of the network. The main reason is they are responsible for food safety regulation and enforcement in China and their duties often overlap. Therefore, in order to ensure the food safety of the whole chain, the aforementioned departments must collaborate.

⁹ Because the degree of mediation is 0 in most nodes, if the degree of mediation is used to plot the size of nodes, some nodes will be reduced to one point and the type information of nodes will be lost. Therefore, the degree of centrality index is adopted.

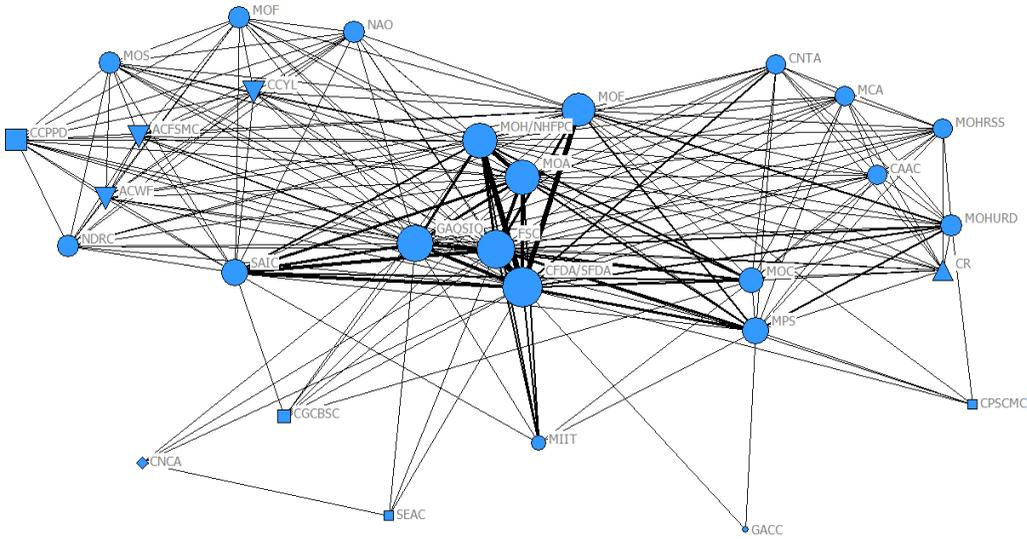


Figure 2. Regulatory Cooperation Network, 2011-2017

Source: The author's dataset.

Note: Node shape indicates the type of actors: Circle-Administrative Agency; Square-CPC Organization; Up triangle-Enterprise; Diamond-Public Institution; Down triangle-Social Organization.

For 2011–2017, the abovementioned departments still maintained their core positions, and their connection was very close. In addition, the FSC, the Ministry of Education (MOE) and the Ministry of Public Security (MPS) also entered the central group (see Table 4 and Figure 2).

It should be noted that the main responsibilities of the MOE and the MPS are not food safety regulation. The elevation of their status is related to the focus of regulation in a specific period. Specifically, when the regulation involves campus food safety, the assistance of the education department is needed; collaboration between the MPS and the food safety authorities is related to the implementation of the four most stringent standards, aimed at promoting an effective link between adminis-

trative law enforcement and criminal justice. It is noteworthy that in terms of vertical comparison, the value of the betweenness centrality of the core actors is significantly reduced. Horizontal comparison shows that the gap of the betweenness centrality between each actor is also greatly reduced, which indicates that the difference of the status gradually narrowed, and the power imbalance among actors is an obstacle to the realization of collaborative governance (Purdy 2012). This trend is undoubtedly conducive to the development of collaborative governance in the future.

The broker analysis further illustrates the role of the above actors. For 2004–2010, the number of coordinators in the network is the largest, and its proportion is much higher than that

Table 4. The centrality of supervisory subjects in 2011-2017

Regulatory Agency	Weighted Degree	Degree Centrality	Betweenness Centrality
CFDA/SFDA	99	28	0.147697783
FSC	80	27	0.098755984
MOH/NHFPC	63	24	0.042627236
MOA	61	24	0.042627236
GAQSIQ	56	26	0.081427942
SAIC	47	18	0.014566012
MOE	45	23	0.041672965
MPS	37	17	0.030728773
MOC	35	16	0.008361678
MOHURD	23	14	0.004761905
MIIT	19	8	0
CNTA	15	13	0
CR	14	13	0
CCPPD	14	14	0
NDRC	14	14	0
MOS	14	14	0
MOF	14	14	0
NAO	14	14	0
CCYL	14	14	0
ACWF	14	14	0
ACFSMC	14	14	0
MCA	13	13	0
MOHRSS	13	13	0
CAAC	13	13	0
CPSCMC	10	5	0
CGCBSC	7	7	0
SEAC	4	4	0
CNCA	4	4	0
GACC	2	2	0

Source: The author's dataset.

Table 5. Distribution of broker roles in 2004-2010

Broker Role	Proportion
Coordinator	77.19%
Itinerant Broker	0.00%
Representative	22.01%
Liaison	0.00%

Source: The author's dataset.

Table 6. Frequency distribution of regulators' broker role in 2004-2010

Regulatory Agency	Coordinator	Itinerant Broker	Representative	Liaison	Summation
SFDA	45	0	8	0	53
MOH	12	0	5	0	17
GAQSIQ	12	0	5	0	17
MOA	6	0	4	0	10
MOC	6	0	4	0	10
SAIC	7	0	0	0	7
Summation	88	0	26	0	114

Source: The author's dataset.

Table 7. Proportion distribution of intermediary roles in 2011-2017

Broker Role	Proportion
Coordinator	39.89%
Itinerant Broker	1.22%
Representative	49.83%
Liaison	9.06%

Source: The author's dataset.

Table 8. Frequency distribution of intermediary roles of regulatory subjects in 2011-2017

Regulatory Agency	Coordinator	Itinerant Broker	Representative	Liaison	Summation
CFAD	77	3	95	19	194
FSC	59	3	87	19	168
GAQSIQ	59	1	72	14	146
MOA	43	1	50	8	102
MOH/NHFPC	43	1	50	8	102
MOE	33	1	46	8	88
MPS	23	0	19	1	43
SAIC	13	1	14	3	31
MOC	11	0	10	1	22
MOHURD	0	0	8	1	9
Summation	361	11	451	82	905

Source: The author's dataset.

of other roles, which means that the interest coordination mechanism within groups is relatively sound, and the inter-group interests coordination mechanism is underdeveloped (see Table 5). The reason is that the collaborative relations during this period were mostly confined to the internal interaction of administrative agencies, and the size of other groups was extremely limited, which led to the fact that most of the brokers and their connecting subjects were affiliated with administrative agencies. Specifically, the SFDA is the most important broker in the network, playing a variety of roles more frequently than other actors (see Table 6). The main role of the SFDA is to mediate conflicts of interest within the group, accelerate the flow of knowledge and resources within the group, and

promote intra-group collaboration.

For 2011–2017, thanks to the diversification of group types and the expansion of group size, the role of brokers in the network has become increasingly diverse, with the emergence of an itinerant broker and liaison. Moreover, with the enhancement of network heterogeneity, the role of brokers in maintaining inter-group communication has increased: the spokesperson accounts for the highest proportion, the intra-group coordinator dropped to the second place, the liaison increased, and the proportion of brokers serving as inter-group coordinator exceeds that of intra-group coordination, which indicates that the inter-group coordination mechanism is constantly improving (see Table 7).

SFDA is no longer the dominant actor. FSC and SAIC also play an important role (Table 8). They not only contribute to maintaining intra-group collaboration, but they also play an important role in promoting inter-group collaboration. More importantly, in the single-core network structure, the only core actor controls the bulk of network exchange. On the one hand, it could engender risks that the core entity distorts resources and information flow out of self-interested motivations. On the other hand, it also reduces the ability of the collaborative network to resist external challenges. In contrast, the multi-center network structure means that no one can dominate the collaboration between the main bodies. There are always alternative ways to avoid the aforesaid risks to a certain extent and to ensure the effective operation of the collaborative network.

Overall, non-administrative actors are in a relatively disadvantaged position in the food safety collaborative regulatory network. The key actors are food safety authorities such as the CFDA. Moreover, the hub group is expanding, including the MOE and other departments not directly relevant to food safety regulation, which will help complement each other's strengths and inject new vitality into the cooperation network.

Conclusion and Discussion

Based on the SNA, this paper investigates the collaborative regulation network of food safety in China from 2004 to 2017, and draws

the following conclusions.

In the whole-network dimension, the collaborative network has become increasingly denser, the size has also expanded, and the network heterogeneity has strengthened. Frequent interaction can inhibit opportunistic behavior and encourage actors to follow the principle of reciprocity, which is conducive to building trust and is of great significance to the survival of collaborative networks. In this scenario, the diversification of collaborative actors and the frequent interaction between groups are more conducive to realizing a synergistic effect and to promoting the healthy evolution of the network. The reason is that, compared with weak linkages, strong linkages not only facilitate the rapid diffusion of new ideas in the network, but also make them more acceptable to all parties, thereby enhancing the adaptability of cooperative networks (Rost 2011).

In the group dimension, the administrative agency is always the central group of the network, and the status of other groups gradually rises. The pattern of collaboration is slightly different in different periods: in the early stage, collaborative relations are limited to intra-group collaboration, i.e., interaction and communication between administrative agencies. With the increase of network heterogeneity, the status of non-administrative organizations rises and the coordination role of administrative agencies has also become prominent. Inter-group relations are strengthened significantly, promoting the diversification of collaborative relations.

In the actor dimension, food safety authorities such as the CFDA have always been the most important actors, not only actively collaborating with other actors, but also serving as brokers connecting different groups. The imbalance between actor statuses within the central group has narrowed, which reduces the risk of alienation of collaboration into unilateral domination. In addition, the central group has expanded, including the MOE and other departments not directly relevant to food safety regulation, which inject new vitality into the cooperation network.

Generally speaking, the mode of collaborative regulation has changed from administrative domination to multi-agency cooperation under the leadership of administrative agencies, that is, from administrative domination to administrative leadership. The so-called administrative domination refers to the absolute dominance of the administrative agencies in the regulatory network and almost complete control of regulatory activities. Its dominant position is reflected not only in the node status of administrative agencies, but also in the great proportion of exchanges within administrative agencies in network communication. Administrative leadership refers to the relative dominant position of administrative agencies in the regulatory network, which has great influence but is not likely to dominate the collective action process. This is not only reflected in the increase in the number of nodes in non-administrative agencies, but also in the increase in the contribution of non-administrative organs to inter-group exchanges.

In the long run, this change is conducive to the sound development of China's food safety collaborative regulation, and we should make efforts to promote collaboration in the following aspects. On the one hand, we should take the opportunity within institutional restructuring to actively promote mega-regulation. In 2018, the State Administration for Market Regulation was set up amid the reform of government institutions to eradicate the pernicious problem of regulatory fragmentation. According to the analysis of the group dimension, we can see that the administrative agencies are relatively closely linked, which provides a good condition for the integration of the organization. But this is only the first step; there is also a need to make progress in personnel arrangements and organizational culture to put functional integration into practice (Ma and Christensen 2019).

In terms of personnel arrangement, except for professional and specialized positions, the method of cross-appointment should be adopted for comprehensive management positions, especially core personnel arrangements, which would not only break the original identity stereotypes and accelerate the formation of new identities, but also promote the fairness of the reform plan and reduce conflicts of interest.

In terms of organizational culture, we should set up new common norms and values as soon as possible, build a new organizational culture, and be alert to the negative effects of the original departmental culture degen-

erating into sub-cultures and causing factional bias.

In addition to institutional integration, food safety regulation also requires collaboration between core functional departments and other government departments. To this end, we need to ensure the institutionalization of collaborative relations by signing formal collaborative agreements and holding joint meetings. We also need to incorporate cross-sectoral collaboration tasks into assessment matters and form a cooperative incentive and accountability mechanism.

On the other hand, government agencies should appropriately empower other stakeholders to participate in collaboration. Social co-governance has recently become an important principle of food safety regulation, emphasizing the mobilization of social organizations, trade associations, and other social actors to actively participate in food safety regulation. It should be noted that in practice, co-governance of multiple actors should be regarded as a

means to improve governance capacity, rather than the ultimate goal. Therefore, it is necessary to take the improvement of governance performance as a guide, consciously selecting the right partners. For example, social groups such as trade unions, the Communist Youth League, and the Women's Federation, which have a deep base, are helpful for promoting food safety knowledge and other grassroots activities.

It is worth noting that this study is limited in three ways. Firstly, the method of data collection is defective, which may lead to omission of some policies, and the conclusion may be biased. Secondly, this paper focuses on descriptive analysis, and does not deeply explore whether the evolution of collaborative relationship improves regulatory performance. Finally, due to the limitation of data collection, this paper focuses on formal collaborative relationships, but informal cooperative relationships are also very important. We hope future research will address these limitations.

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