A network analysis of the food systems in regional economy: Primary factors influencing consumer utility

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***ABSTRACT*:** Growing concerns about the demand for quality food have widely been recognized as a primary issue for regional economies in the last decades. This is often coupled with the duality between locally self-grown food markets and globalized food chains. When considering food quality, the concept of 'food systems' in which all stakeholders interact with each other and collectively bring added value provides us with a practical and analytical framework.

The objective of this study is twofold: first to explore the holistic structure of food systems; and second to clarify those factors which represent the performance of food systems from the perspective of consumer utility. In this paper, a focus of analysis is placed on food quality. By employing network analysis, the whole system concerning the production, delivery, and consumption of horticultural products in Japan are examined as the subject of a case study. This study compares globalized food systems and local systems, through which their differences are elicited. The result suggests that geodesic distance and centrality is the key indicator for understating the determinants of performance. Finally, the authors indicate the possibility for strategizing regional vitalization through the provision of quality food.

KEYWORDS: food system, social network, food quality

1. INTRODUCTION

1.1 Food Quality

The expansion of global food systems have been accelerating commoditization and standardization in food quality. In contrast, new concepts on food systems are discussed from the food quality perspective. Literature has introduced various frameworks for analysis, such as a concept of an alternative food system, embeddedness, and convention theory (Marsden and Arce 1995; Murdoch et al 2000; Watts et al 2005). Some of the studies emphasize that food quality is a diverse concept which is socially constructed and should be understood in the context of social interactions-(Ilbery and Kneafsey 2000; Mansfield 2003; Marsden and Arce 1995).

Under this trend the value of local food systems, in which people consume locally grown foods, are again being recognized. In fact, the demand for locally grown food has been rising in Japan. Farmers' markets have been highlighted as one of the embodied local food systems for consumers' access to locally grown food. The agricultural census states that the number of farmers' markets (excluding unmanned and mobile-stand types) has swelled up to about 17,000 nationwide in 2010, increasing by 24.2% in five years, though the Japanese household expenditure on fresh vegetables in 2010 fell down about 20% compared to 2000(Ministry of Internal

Affairs and Communications 2011).

1.2 Impacts of Farmers' Market

When considering impacts of local food consumption at farmers' markets, a number of studies have coped with the matter. Consumer preferences on locally grown food with the willingness-to-pay of premiums have been examined (Conner et al, 2009; Adams and Salois, 2010). In addition, the economical positive effects have been investigated. Katsuki et al. have presented that a farmers' market benefits on producers in net earnings, consumers in lower purchasing prices and local residents in new employments created by markets (Katsuki et al. 2009). It has been estimated that a farmers' market would increase the proportion of vegetable farmers in 6 km radius around a market (Nakajima et al. 2011).

While these findings are focused on the achievements of consumers or farmers' markets in a specific region, studies that compare the structure of the market have been few thus far. A food system is composed of various players' actions as a form of a structured network and it is required to be analyzed from that viewpoint. Therefore the objective of this paper is twofold. The first objective is to explore the holistic structure of local food systems as networks focusing on farmers' markets. The second objective is to clarify the factors which affect the performance of food systems from the perspective of food quality. Along with the results of this study, a possibility for directing regional development is discussed.

2. METHODS AND CASE STUDY

2.1 Social Network Analysis

As aforementioned, various players are involved in provisioning foods as a system. In order to identify how players act in what structure, this research employs an exploratory social network analysis approach.

The framework of social network analysis is one of the effective tools that provide a way of visualizing social relationships between actors. The software called "Pajek" is applied for describing the networks and calculating indicators which are examined to grasp the characteristic factors of the local food networks.

The indicators we use are density and centralization for representing the character balance of the whole network. Centralization indicates the degree of network dispersion, expressed in the range of 0 to 1. Closeness centrality is based on the concept of geodesic distance and shows an assuming influential player, who accesses to others with minimum indirect connections. In addition, dissimilarity scores are computed to visualize the players' structural pattern. This score tells us the similarity in roles expected within its relation with other players. Players in a similar position and a role are substitutable and exchangeable. They tend to differentiate from others and, consequently could bring competitive relationships.

Later on, the four indicators are interpreted considering the insights gained through interviews in the discussion section.

2.2 Case Study

2-2-1. Objected Region

This study samples Ibaraki prefecture, which possesses the largest producing area of horticultural crops second only to Hokkaido. Vegetables hold almost 80 % in all oh the horticultural products. It has been holding the top share for years in the Tokyo Metropolitan Central Wholesale Market, the largest wholesale market in Japan, and the share has been still growing. However, selling prices at the market has been falling downward. This circumstance has forced the prefectural office and farmers to promptly

take action. As a consequence, farmers' markets have become an attractive means of selling their products at a higher price, combined with the increased demand for locally grown food. The Ibaraki prefectural office provided a subsidy for constructing farmers' market and resulted in greatly increasing the number of markets from 135 in 1994 to 289 in 2011[1].

Farmers' markets have tripled in number in the southern region of Ibaraki, and account for over 35% of all farmers' markets in Ibaraki. Furthermore, the number of farmers who participate in farmers' markets increased by 29% in four years since 2006. An abundant trend from 1990s can be recognized. On the other hand, some farmers' markets have gone out of business and 7% of farmers left farmers' markets in 2011. As the data shows, not all farmers' markets have benefited from excessive competition among farmers' markets and food retailers with global food chains. Thus, southern Ibaraki is possibly worth a closer examination as it could reveal complex patterns of the formation of farmers' market network.

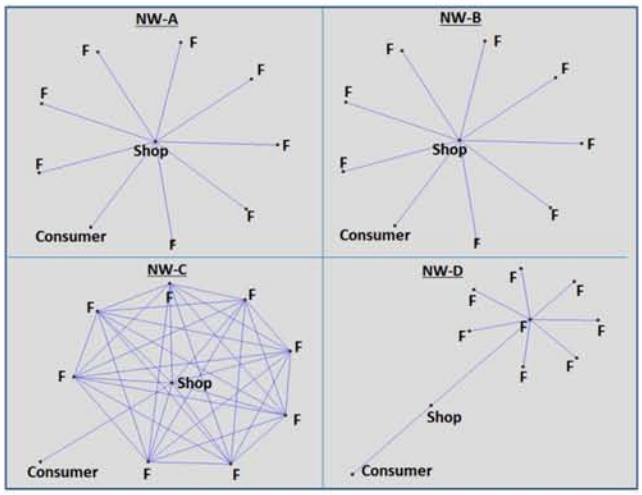
As it is practically not realistic to obtain all the nodes and links that compose the entire local food networks of this region, four farmers' markets with different types of management entities are selected as sample sub networks. The inputs for describing networks are based on the interviews conducted by the authors and various published data. Here the management entity and operation policy for the sample farmers' markets are summarized as follows: (A) Agricultural Cooperative, attaching importance to freshness, price reasonability for consumers and a variation of products as values (B) Co-operation by neighboring farmers, values in freshness (C) Agricultural Corporation, high quality in taste and appropriate price for farmers' reproduction, and (D) Super Market, which operates in-shop style local farmers' market, freshness and reasonable price as same as (A) (referred to henceforth as NW-A, NW-B, NW-C, and NW-D, respectively).

2-2-2. Network Definition

In describing a network, a player with specific roles in the food network such as a farmer, farmers' market shop (operating entity), and consumers, is defined as a node. Consumers could be excluded if analysis focuses on production chain alone, but we consider consumers as a collective member of network because they fill an important role in defining and delivering values.

A connection as a tie between nodes is defined if any transaction is confirmed. Here, transactions include both physical and contractual interactions - for example, selling products, agreement on products planning, etc. Assuming that a transaction is made interactively, single undirected graphs are applied. The images of the described networks are shown in Figure 1.

Figure 1: Images of the networks



("F" stands for a farmer in the graph above)

2-2-3. Performance Definition

As a measure of performance of the networks, sales amount per farmer in each network is considered. As stated in earlier sections, the value in terms of food quality that each farmer, farmers' market, and consumer pursue might be very diverse. In short, if a

[1] Ibaraki prefecture 2012. Unpublished data (in Japanese).

concept of value in food quality is unmatched among them, products sell poorly. Accordingly, sales per farmer can be an indicator for evaluation if the network meets consumer preference.

3. RESULTS

3-1. Network Indicators

The density and closeness centralization indicators are presented in Figure 2 for measuring the characteristics of the whole network. Figure 4 shows the variance of centrality of each node in its network.

Figure 2: Centralization and density

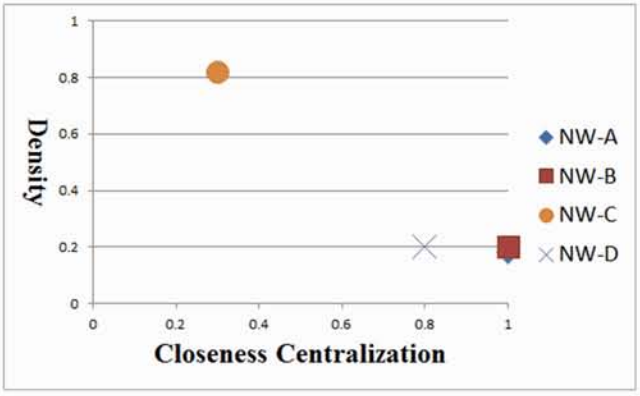
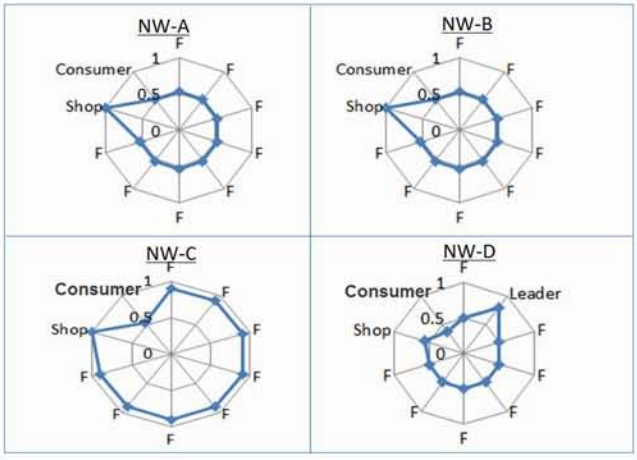


Figure 3: Closeness centrality



It is apparent form Figure 2 that NW-C has a different characteristic from others. It is a dense and cohesive feature network with unbiased centrality at supplying side.

On the contrary, no remarkable difference in NW-A, NW-B and NW-D is observed. They are in low density and in dispersed centrality balance of players. When looking to centrality of each node, NW-A and NW-B show the same structural features in which only the management entity of farmers' market is in a central position and others in periphery. In NW-D, one of the farmers has the highest centrality with the value of 1 who positions as a hub. Consumers of NW-A, NW-B and NW-D stand in at a further distance comparatively.

Regarding the indicator of dissimilarity, all of the farmers selling at the shop and even consumers are in the structurally same position in NW-A and NW-B. NW-C farmers and the shop are completely equally positioned in the network. Similar roles are allocated to play themselves. NW-D indicates that farmers excluding the 'hub' farmer have the same positioning under the hub farmer and shop as well.

3-2. Network Performance

Based on nationwide data reported by the Organization for Urban-Rural Interchange Revitalization, the average sales amount per farmer at a farmers' market has been calculated. Sales amount data of four samples are obtained from the interviews or their publications. The performance is classified into three levels based on the criterion of the average of sales amount per farmer. Table 1 lists the performance of each network along with its classification.

Table 1: Performance of the network

Performance classification	Network
Below average	NW – B
Average - 250%	NW-A, NW – D,
250% upper	NW-C

4. DISCUSSION

In this section, we discuss the characters of networks with performance presented above.

Players are closely and actively connected in NW-C, and the farmers and the shop are in structurally equal position and in homogeneity. From this structure, it can be inferred that this kind of network tends to be theoretically cooperative and easily reach an agreement because they hold the cohesive interrelations. In addition, farmers might negotiate with consumers with a strong bargaining power because they are able to keep themselves at an optimal state. As far as the present cases are concerned, this inference about the structural characteristics seems to be consistent with the observations. As the performance indicator shows, this network successfully achieves high sales. The farmers cooperatively make the products planning, engage in the activities for checking and raising quality, and set the prices of their products relatively higher than those at other farmers' markets. In fact, the agricultural cooperative that operates the shop is aiming to offer a place for both farmers and consumers as an information sharing platform for quality food. Under this managing style and structure, farmers are able to effectively share information on what consumers prefer through network. We infer that this shop management style is one of the cause for maintaining cooperative structure and high performance.

On the other hand, the NW-D works in a hub-type structure, in which a farmer coordinates other farmers. They communicate only through this coordinator. In principle, this hub-type formation could bring a tense relationship among the farmers, because an asymmetric arrangement can be made between a player in a hub role and others in the contested position to gain an excessive benefit. Typically, a player is not motivated to accept that kind of coordinator role without some merit.

Contrary to the expected behavior discussed above, the farmers form cooperative relationships under the hub person in reality. In NW-D, the farmers' market section competes with another vegetable section which procures from other regions in Japan and abroad. Such an environment prompts the local farmers to form a harmonious coalition as a way to confront non-locally grown foods. A farmer in the hub position would undertake the coordinator role as a result of considering the optimization of collective benefit for the local farmers, even if it generates additional transaction costs.

The results of NW-A and NW-B show the same structure. In these networks, farmers and consumers are in a contested position as an underlying structure. They bargain on food quality through the farmers' market. However, there is a big discrepancy between the actual outputs. In reality, farmers in NW-A have direct communications with the consumers at the shop, and by being involved in events outside of the transactional network. Having another layer of network for a mutual flow of information might reveal the networks function more explicitly.

From these four groups of samples, two factors affecting the performance of the network can interpretively be extracted. The first factor is the players' activeness in close geodesic distance in a structure. In this case study, density and centralization indices show the same trend, thus such measures cannot be utilized to identify which element is more influential. However, less polarized centrality is a key factor for the result of NW-D, and it is thought to have an impact on spreading and sharing what they need for achieving high performance. It is crucial for a network to share some common objectives in order for its players to head in a same direction. In the case of food network, perception of consumers' preference

on the food quality is shared and spread inside the network, and demanded quality of food is provisioned.

Another factor is who and how to take a balance between structurally potential rival players. A harmonious cooperation in a network might result in collusion if it goes too far, and excessive competition might make them fall altogether, though such cases are unexamined formally in this study. Our samples imply that cooperation between farmers leads to satisfactory performance at the farmers' market operation. Needless to say, an involvement of an influential player in a network is essential for a cooperative coalition. Furthermore, we recognize two types of cooperation: intrinsic and autonomous cooperative relationships as shown in NW-C; and opposing extrinsic pressure as shown in NW-D. Both networks achieve a certain level of performance in this case, so that it cannot be decided if one is better than the other.

5. CONCLUSION

This paper has analyzed the structure of farmers' markets networks as sub-networks of a local food system. The factors affecting performance from the network structure have been considered.

It is found that farmers' markets function as places where consumers and farmers communicate on food quality cooperatively or where they bargain for pursuing each quality of food. Involvement of an influential player in a cooperative manner, not in competitive way, might be a determination of the performance of the network. What we have explored from this sub-network level analysis could possibly be a basis for designing a food system in geographically widespread regions.

This paper limits itself to study the basic structure of sub-networks. Aspects to be incorporated still remain for further research on food systems. First, detailed network analysis including the weight of ties, geographical distance between nodes, and relationships between sub-networks is needed to form a more comprehensive picture. Secondly, network performance in terms of social and cultural impacts should be considered. Thirdly, the clarification of elements which determine structural balance between cooperation and competition should be made. By considering these into research, it would show us a more effective and appropriate model for food systems.

Finally, we conclude with the findings from the regional development perspective. Branding has been often regarded as one of the effective methods to differentiate and promote agricultural products from the viewpoint of producers. However, not all production regions have its original brand. The case in this paper, Ibaraki prefecture, is a region that practices mass-production. They are opening up local, embedded markets by constructing local food networks. This means that consumers, farmers, and other players in the networks admit the value in locality *itself*. Furthermore, as seen in NW-D, locally grown foods can differentiate themselves in food quality value, which prompts local farmers to unite and form a cooperative relationship in order to resist the economic advantage of imported foods. In summary, this indicates the importance of shared understanding of food quality within each locality. A social system for evoking and supporting its locality is necessary.

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