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Network Analysis of TV-Viewing Patterns in Multi-Channel Circumstances*

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This study uses the network analysis method to overcome limitations of previous research that had inaccurately examined the phenomena of fragmentation and polarization in TV-viewing behaviors. First of all, viewer ratings were analyzed, which consisted of 298 panels in 2004 and 2007. The benefit of this panel data was not only to secure the validity and credibility of the data, but also to figure out the change of viewing patterns. The result of network centralization and centrality analysis was that fragmentation became stronger as the number of channels increased. In other words, audiences dispersed to professional and specialized channels. However, they came together from terrestrial broadcastings to other channels again. The re-concentration phenomenon appeared apparently in drama channels that belonged to terrestrial (non-satellite or cable) broadcastings. In addition, sub-network analysis showed that "small but loyal viewer groups" kept on increasing. This result indicates the depth of polarization, which means audiences have a tendency to view common genre programs according to their preference.

Keywords: *Network Analysis, Fragmentation, Polarization, Re-concentration, Korea*

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I. PROBLEM STATEMENT AND PURPOSE OF STUDY

The audience share of terrestrial (non-satellite or cable) TV channels continuously decreased from 85% in 2000 to 60.7% in 2006 and at last to 50% in 2008 (AGB Nielsen Korea 2008). The multi-channel situation causes this change in viewing patterns, which leads to concerns regarding the demise of terrestrial broadcasting. TV viewers choose a channel that suits their own tastes in a multi-channel environment that provides diverse, specialized, and narrowly focused programs. In this change of viewing pattern, a form of fragmentation and polarization emerges. As the number of channels rapidly increases, TV-viewing patterns that used to be concentrated to a few terrestrial channels fragment into various channels. In particular, TV viewers watch particular channels according to their own tastes and the features of the channel, which is known as the polarization phenomenon, rather than watching various channels (Webster and Phalen 1997; Webster 2005). Fragmentation and polarization of the TV-viewing patterns are meaningful in terms of their impact on the role and function of broadcasting. This is because that fragmentation and polarization can attenuate the social integration, which used to be regarded as the key role of broadcasting (Katz 1996). In addition, they may make the public favorable to certain advertisers and producers, or they may cause group polarization, which causes groups to exclude any opinions or points of view different from their own (Sunstein 2001). That is to say, fragmentation and polarization phenomenon in a multi-channel environment may mean the role of media is changing from society-integrating media to society-segmenting media (Turow 1997).

The fragmentation and polarization phenomenon is a macro-viewing pattern, which aggregates the viewing patterns of individual TV viewers in large scale (Webster and Phalen 1997). In particular, polarization is a subset of fragmentation. As channels increase, TV viewers move from a few terrestrial broadcasting channels to many different channels, such as cable and satellite channels according to their own tastes. When integrating these groups of viewers, who congregate to a particular channel, the viewing pattern at large looks scattered; it looks fragmented. Not only does the fragmentation and polarization phenomenon occur recursively and simultaneously from

individuals to groups and groups to the whole, but the change in the whole TV-viewing environment also leads back to changes in individual viewing behaviors. This phenomenon is often adopted to explain not only TV-viewing patterns, but also Internet usage patterns (Hwang, Y. 2002; Yim, J. 2003). Many previous studies explain the fragmentation and polarization phenomenon as a different concept or phenomenon, rather than conceiving of them as the related phenomena (Kang, N. and Cho, S. 2007; Lee, S. and Kim, K. 2002; Heeter and Greenberg 1988; Webster 2005; Yim, J. 2002, 2003).

Fragmentation of TV-viewing pattern has been explained by audience share, while the concept of channel repertory is used as evidence to explain polarization. In particular, by referencing the share of audience, fragmentation has been explained as a phenomenon in which TV viewers, who used to be watching only a few terrestrial TV channels, move to and scatter to many different channels. The limited number of channel repertory has been suggested as evidence to support and explain polarization. This is because polarization is restrictive because TV viewers use the limited number of channels according to their own tastes and selective exposure process. However, using the share of audience or the number of channel repertories only suggests the possibility of fragmentation and polarization, rather than explaining them in more detail. That is to say, it does not explain to which channel viewers move from terrestrial channels. In addition, it does not show how viewers organize their channel repertory. More than anything else, TV-viewing pattern should be considered in relation to the "flow" of channel usage rather than the amount of viewing time. Therefore, fragmentation and polarization can be properly understood when considering both the flow of channel viewing, which is a qualitative concept, and amount of viewing, which is a quantitative concept.

In conclusion, to precisely understand the patterns of channel usage, it is necessary to use a method that can macroscopically and microscopically analyze the viewing amount and viewing flow. Network analysis meets all these requirements and can explain the mutual dynamics of both action and structure of TV viewing. Thus, through the analysis of network structures and behaviors, we can precisely explain dual-structure of viewing patterns that occur through a structure such as a channel viewing behavior (action) and by a channel structure re-formed by viewing behaviors.

The most significant feature of fragmentation and polarization that occurs in a multi-channel environment is that viewers show high loyalty to particular channels. Webster (2005) argues that the existence of "small but loyal viewer groups" plays an important role in explaining fragmentation and polarization. In fact, identifying groups of "small but loyal viewer groups" shows the pattern of polarization TV viewing, and the sum of these small groups at a macroscopic level supports fragmentation. However, Webster (2005) did not distinguish between "small but loyal viewer groups" and "small and not loyal viewer groups." Also, the study of Cho, S. and Kang, N. (2008) reported only the possibility of the existence, rather than actually finding the "small but loyal viewer groups." Therefore, this research focuses on overcoming methodological limitations of previous studies on viewing patterns and on identifying "small but loyal viewer groups," which provides actual evidence of fragmentation and polarization. To do this, we investigate specific aspects of fragmentation and polarization, which result from increased channels, and also we examined the existence and features of the "small but loyal viewer groups" by employing network analysis.

II. ANALYSIS OF TV-VIEWING PATTERNS AND NETWORKS

1. The Network Structure of TV-Viewing Patterns

When viewers watch TV, they view several channels. Viewers connect these channels together creating a kind of network between those channels. Therefore, a network structure can explain the choice of channels by the viewers.

Figure 1 shows how viewers form a network of channels. For example, when viewer, A1 watches channels Ch 1 and Ch 2, they form a network. Figure 2 explains a feature of the network when a new channel is added. In other words, it represents the structure of the network according to increased channels. If viewer A1 watches Ch 1 and Ch 2 predominantly and starts watching Ch 3, it would be very rare that A1 stops watching Ch 1 and Ch 2, then only watches Ch 3. This implies that the structure of a channel network

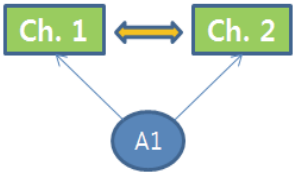

Figure 1. A viewer and channels

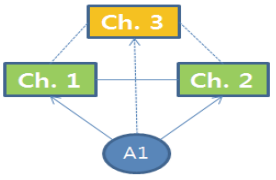

Figure 2. Adding a new channel

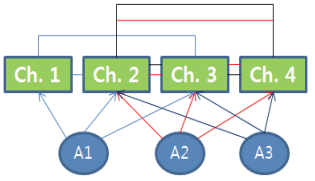

Figure 3. A diagram of the network

is a free scale network. For example, in the case of airport networks, a new airport cannot operate without connections to a highly utilized pre-existing airport, which would play the role of a hub in the airport network. As one would expect, the new airport should construct airways connecting to the pre-existing airport. Thus, establishing a new airport not only disperses people who use airports, but it also strengthens the role of a hub airport (Barabasi 2002). We can apply this concept to viewing patterns. When a new channel is added, viewers may move to a new channel, but at the same time, the status of terrestrial channels can be improved as well since viewers predominantly watched terrestrial channels, before adding the new channel. Therefore, Ch 1 and Ch 2 have a strong connection, and Ch 1 and Ch 3, Ch 2 and Ch 3 have a weak connection. Figure 3 shows a diagram of the network that three viewers choose from among four available channels according to their own preferences. Viewers form channel usage patterns; A1 shows Ch 1-Ch 2-Ch 3, A2 shows Ch 2-Ch 3-Ch 4, and A3 shows Ch 2-Ch 3-Ch 4. This implies a channel usage pattern of an individual viewer at the most basic level that. At a higher level, we can see a channel usage pattern that forms subordinate groups; A1 and A2 show Ch 2-Ch 3, A2 and A3 shows Ch 2-Ch 3-Ch 4, A1 and A3 show Ch 2-Ch 3. Therefore, the same channel usage pattern of all viewers (A1, A2, and A3) is Ch 2-Ch 3.

In this way, viewers' channel usage can compose a network between channels, and the network consisting of the channels can show channel usage patterns on whole, subordinate, and individual levels. The analysis of these different levels provides evidence for identifying viewing patterns, such as fragmentation, polarization, and channel repertory.

First, fragmentation can be understood through a structure of a whole

network, which consists of all channels that viewers use. When a network looks like a net that evenly spreads and connects, it means that fragmentation has occurred, while when a network is concentrated to certain channels, it implies that the concentration phenomenon has occurred. Polarization is identified from a sub-group network between channels, which viewers commonly use. The method to analyze a sub-group is called subgroup-network analysis. Subgroup-network analysis explains polarization of viewers and also identifies "small but loyal viewer groups" by distinguishing groups with higher connectivity strength between channels. In other words, although there are few viewers, if viewers exclusively watch certain channels, this becomes a subgroup network. In addition, if we can identify centralization and importance of channels by selecting commonly used channels among the whole network, we can understand the current status of channels that viewers moved to due to fragmentation.

In order to examine these features of the network, it is necessary to use main indexes including a status of whole network as well as network centralization and centrality of node. When a network is excessively complicated, interpreting network status can be either intuitive or it could be difficult. For this reason, we consider both the status and indexes, which the whole network consists of to explain the features of networks more precisely.

2. Fragmentation of TV-viewing Pattern and Network Concentration

Viewers keep moving to professional and specialized channels that suit their own preferences. This phenomenon of viewers moving and scattering to various channels is called "fragmentation of viewers" (Webster 2005). The fact that TV-viewer ratings of terrestrial channels are continuously decreasing, while cable TV ratings are steadily increasing, already implies fragmentation. Webster (2005) confirmed this feature of fragmentation by using the share of the audience. He argued the fact that among 327 channels, the top ranked 62 channels had a 65% share of the audience while the other 265 channels had the other 35%.

More than anything else, since fragmentation is the opposite of concentration, concentration factors (Gini coefficient or Hirschman-Herfindahl index), which represent inequity of resources, were often used as evidence of

fragmentation. Webster (2005) selected the top ranked 62 channels among all viewing channels, and measured the share of audience and as a result proved that Pareto's Law can be applied. In particular, Webster claimed that fragmentation had occurred due to a horizontal diversity by mentioning that the number of viewers, who watched the top ranked broadcasting companies, is relatively small compared to other media. In addition, according to Kang, N. and Cho, S. (2008), the share of viewers watching top ranked programs was decreasing. They argued that the amount of concentration to particular channels has been lowered by providing the fact that Gini coefficient and Hirschman-Herfindahl index have decreased from 2000 to 2008 as evidence to support fragmentation.

In analyzing networks, the concept of density as an index to imply inequity of channel usage can be applied. Density refers to each connecting point. In other words, it is the connective density between nodes, which is calculated by dividing the number of actual ties by the total possible number of ties. Therefore, high density means that nodes are inter-connected tightly, which implies that the number of viewers sharing channels is high. On the other hand, low density means that the number of viewers sharing channels is relatively low, which implies viewers' unequal use of channels.

However, since density is likely to depend on the number of nodes it is necessary to reinterpret the concept of concentration, in which it represents the degree-connectivity of the actual audiences to a particular node. The indexes that represent concentration are degree, closeness, and betweenness concentration. While degree concentration is an average concept referring to the number of connecting relations, closeness and betweenness concentrations are related to the concept of variance. Degree concentration shows the tendency toward particular channels; closeness concentration refers to the distance between networks; and finally, betweenness concentration indicates the concentration of channels that play a role of a broker. In other words, concentration is an index, which implies that a viewer plays a central role, while the other viewers are not central. In particular, concentration indexes that are used for network analysis show not only the degree of inequality, but even show the form of inequality, which inequality indexes cannot represent. If the concentration is close to one a star shaped network will form and if it is close to zero a circle network has formed.

3. The Importance of Each Channel and Network Centrality

Whole network concentration is a concept used to explain the fragmentation of viewing behavior, in which individual channels change on a group level. Therefore, to understand the detailed information of fragmentation we need to look into the change in status and importance of each channel.

Until recently, the importance of channels was judged by viewer ratings. However, judging the importance and status of channels simply by ratings, without a proper understanding of relationships to other channels, could be problematic. This is because the importance of channels can be changed through the relationship between channels. Certain channels having higher ratings is no guarantee of fast information or better clarity in communicating information compared to other channels. For example, viewers do not watch one channel continuously, but since they change channels they obtain information from the short-watched first channel. Therefore, to understand the influence a channel has one must understand the relative status formed between channels.

Since network analysis can systematically approach the actor that plays a major role in a network, it could be the right tool to look at the status of channels. The doer that is placed in center of the network becomes stronger in the group (Brass 1984), makes innovation easier (Ibarra 1993) and becomes more successful (Baldwin et al. 1997). In Network analysis the index centrality is used to measure the position of the center of the network. There are multiple ways to measure centrality. Although each method has its own unique feature generally degree centrality, closeness centrality, and betweenness centrality are used (Son, D. 2002).

Degree centrality is the concept of focusing on the number of direct connections of different nodes to each other. The number of degrees is defined by adding the neighboring nodes that are directly connected to a node. Degree centrality is a way of measuring centrality through the amount of this connectivity. Degree centrality is limited since it only measures nodes that are directly connected and does not account for nodes connected two steps away. However, the biggest role of degree centrality is that it helps identify the channels that play the role of an herb-station. This means that

when a new channel enters, it is highly likely to connect with channels with a high degree centrality terrestrial cable channels that have evolved through herb channels are often successful. Out of the five top watched Korean cable broadcasts, three are terrestrial channels related MMP (MBC Plus, SBS Media Net, KBS N). Since viewers have a strong preference for terrestrial channels, a cable channel that is related to terrestrial channels can easily share the terrestrial channel viewers compared to other cable channels. Therefore, the terrestrial channels and the related cable channels first formed a network, and later on these channels started to share viewers with other cable channels, evolving into a larger network. Thus, degree centrality not only is an index that shows the direction of how a new channel entered, it can also show which channel is the highest information-sharing channel.

Closeness centrality measures centrality by the distance between nodes. Unlike degree centrality, closeness centrality calculates centrality not only by measuring nodes that are directly connected, but also by measuring all indirectly connected nodes in the network. Since the shortest distance is calculated for all the nodes, the center node of the closeness centrality network would be placed the shortest distance from all nodes. Therefore, high closeness centrality indicates that it is easier to approach information and secure and influence a social status. Also being at the center of closeness refers not only to the ability to easily access information but also to the ability to convey information. For example, if one viewer watches channels A → B → C → D in that order, and another viewer watches B → C → A → D, B channel has the highest closeness centrality. Therefore, closeness centrality can become important information for determining efficiency in advertising or publicity

Betweenness centrality indicates how much of a mediator or arbitrator role it plays in the network. Although the broker, like actor, might have low connectivity, it could still play an intermediary role in information flow and exchange between members of the network. An increase in the importance of intermediary roles indicates that there is an increase in communication control and this leads to more dependence from other actors. A channel with high betweenness centrality means that if the channel is lost, there is a high chance that information flow would be lost and viewers' channel pattern use will completely change. If a certain viewer was watching a channel order

of A → B → C, the loss of B does not automatically lead to watching A to C; it leads to totally unpredictable patterns, such as watching other channels to replace B or even stop watching any channels. Also it leads to the loss of information, which was obtained from C. Therefore, betweenness centrality helps identify the channels that play an important role in controlling the flow of information or communication.

Therefore, network centrality indexes reveal the role and status of channels such as: how new channels enter the network and how they communicate and deliver information. In addition, channel centrality indexes provide an interpretation of fragmentation. Through these indexes, we can learn if centrality has moved from terrestrial channels to other channels. If this does occur, these indexes can also help determine which channels viewers moved to and the effects of this movement on other centralities.

4. Polarization of TV-Viewing Patterns (Channel Repertory) and Sub-Group Network

The fragmented viewing behavior is based on the polarization phenomenon, which is caused by viewers' selecting and concentrating on a small number of channels. Although entering a multi-channel era means that one could watch an unlimited number of channels, in truth, one only selects a limited number of channels leading to polarization in viewing behaviors. Especially as professional channels for smaller groups and channels for a particular age group appear, viewers tend to watch particular channels due to personal preferences, time constraints, and limited information about channels (Yim, J. 2003). This phenomenon of watching a small number of channels can be explained by the concept of "channel repertories." This can be defined as "the set of channels" routinely watched personally or as a group (Heeter 1985). One could think of the concept of channel repertory as the viewing habit of a viewer. In other words, channel repertory is a selective process, in which the viewer does not sort through all channels and can reduce the cognitive compilations by using their experiences and preferences in a situation where there are a lot of channels and many channels are specialized (Youn, S. 1996).

Since polarization leads to viewers watching specialized channels, previous researchers understood channel repertory as a phenomenon of viewer ratings

concentrating to particular channels. Yuan and Webster (2006) discovered that by analyzing the whole channel share of audience on the Lorentz curve, viewers are continuously concentrated to certain channels. Kang, N. and Cho, S. (2007) analyzed viewing polarization of elderly who were over 60 and showed that they are particularly concentrated to terrestrial channels compared to other generations. Previous research on channel concentration and channel repertory was predominantly focused on the number of channels forming the channel repertory. Heeter and Greenberg (1988) reported that in a cable environment with 35 channels, viewers on average use only about 10 channels. Fergoson and Perse (1993) measured two categories: Total Channel Repertoire (TCR) and Mindful Channel Repertoire (MCR). Out of 90 channels TCR was an average of 9.96 channels and MCR turned out to be 6.53 channels. Also, Nielsen Media Research (2003) showed that in a family in the U.S. with 200 channels, they only watch 19 channels. In the case of Korea, Choi, Y. and Jang, S. (1998) analyzed viewing behavior of college students and learned that the average number of channel repertory was 12.4. The channel repertory was influenced by the use of the channel guide, channel re-evaluation, channel popularity, and program type preference. Lee, S. and Kim, K. (2001) compared the spread of channel repertories and found that of a total of 50 channels 16.3% of the viewers used 1-9 channels and only about 80% of the viewers used more than 10 channels, an average of 14.8. This research raises some questions since it is not based on true viewer rating data, but on self-reported surveys. Therefore, recently, in order to overcome this problem, analysis of channel repertory that uses real viewing data has been performed. Yuan and Webster (2006) using 34 Beijing channels showed 13 channel repertories; Shim, M. (2005) showed 11 on weekdays and 12 on weekends, while Kang, N. and Cho, S. (2007) reported 4.3 in 2000, 6.6 in 2003, and 7.9 in 2006, indicating as the number of channels increased, repertory numbers also increased.

As we can see from previous research channel repertory research is limited to the distribution or numbers of channel repertories. However, the quality of the channel repertory is more important than the quantity. For example, in a case of 4 channel repertories all four could be terrestrial channels or a variety of channels like terrestrial channels, cable TV movie channel, news, music channels, and etc. In both cases, the channel repertory numbers are the same

but there is a significant difference in channel viewing variety (Lee, S. and Kim, K. 2001).

The quality of channel repertory, in other words, content of the channel repertory should rely on the content of the channels. In a multi-channel environment, fragmentation and polarization occur since channels share similar content, and viewers prefer specified channels depending on the content (Webster and Wakshlag 1983; Webster 1986, 2005). That is to say, as the options have increased, the factor that decides viewing behavior is preference, so the program genre becomes an important decision factor when determining viewer preference (Shim, M. and Han, J. 2002; Youn, S. 1994). Especially since cable channels have a fixed structure compared to terrestrial channels, the viewer content preference is more applicable (Heeter and Greenberg 1988). Choi, Y. and Jang, S. (1998) learned by using cluster-analysis on channel repertory ratio and average viewing days of the week that there were three viewing audience groups: information, sports and entertainment programs. Lee, S. and Kim, K. (2001) analyzed channel preference into 12 channel types. They discussed channel fragmentation by calculating the ratio between channel type and choice of channel repertory. However, this research does not use ratings or share of audience; it just shows an inclusive phenomenon that viewers tend to watch similar types of programs and does not show the proper viewing behavior in relation to the choice of the channel and program genre. The study done by Shim, M. (2005) used real viewer rating data and analyzed programs with at least 10% viewer rating aired on evening times on both weekdays and weekends. Using factor analysis they showed 11 channel repertories on weekdays and 12 on weekends. However, this research was limited to terrestrial programs, and also only represented a specific time frame, which did not analyze the overall channel patterns and was not able to show the detailed flow of viewer patterns. When we summarize the previous research, we learned that the audiences look for the genre that they prefer, and they watch these channels, forming a channel repertory. However, in this case, we could not understand the relationship between channel repertory and program genre, which is a qualitative aspect of channel repertories.

Webster (2005) provided an important piece of evidence on the fragmentation phenomenon of a "small-but-loyal" audience group and also

on how to identify qualitative and quantitative channel repertories. Even channels with very few viewers and a low audience share still have a small but loyal following, which provides strong evidence of polarization (Webster, 2005). However, he learned that in the small but loyal group there were non-loyal viewers and at the end he failed to distinguish the two different groups. Cho, S. and Kang, N.'s (2008) research claims that "small-but-loyal" viewers exist together with "big-and-loyal" viewers and used the fact that audience exposure and channel watching had no relationship as evidence. In other words, this means the two groups co-exist. The "big-and-loyal" viewers who watch terrestrial channels or popular channels with a high demand average exist. There are also the "small-but-loyal" viewers which have a small following, but instead have a long average viewing time exists also. However, this research just simply considered channels with low rating with long viewing hours and did not consider channel repertory or the flow of viewing, resulting in just showing evidence of the existence of "small-but-loyal" viewers.

The "large and loyal" terrestrial channel centered "common-viewer-group" and different and varying channel repertory forming "small-but-loyal" viewer group collectively adds up and makes it seem that all channels are viewed in a fragmented way. Therefore, polarization is a part or sub-group of fragmentation, which results from similar viewing behaviors. A part or sub-group that shares similar interests within a whole group can be identified using sub-group network analysis. Fractions method is an ideal a sub-group network analysis method that can identify sort sub- group networks. In an ideal situation, sub-group networks should be fragmented, but as a real social phenomenon a fragmented network rarely exists. Fractions method is a method that can sort the sub-group networks that are most likely to fragment. In other words, this method forms groups with intra-group high density and with inter-group lower density. The goodness-of-fit depends on the fitness number that represents the relationship of the groups that are grouped. In this research we used the Fractions method to understand if similar sub-groups actually form "large-but-loyal" and "small-but-loyal" groups, and if they do the channel repertory can be sorted by channel content and features.

III. RESEARCH QUESTIONS

Fragmentation and polarization phenomena of viewing behavior occurs recursively and simultaneously from individuals to groups, and groups to the whole. At the same time they are cyclical so that an entire viewing environment also affects the individual viewing behavior. In addition, viewing pattern is a concept that regards the flow of channel usage, rather than the amount of viewing. Therefore, it is necessary to employ a methodology that can consider both macroscopic and microscopic levels as well as the flow of channel usage, the amount of TV viewings, and the quality of the viewings. Network analysis can help understand the behavior flow of an individual, and it is the best way to multi-dimensionally analyze a viewing behavior. Network analysis is qualitative and quantitative method that draws a macroscopic structure from microscopic relationships of an individual.

"Fragmentation of audiences," which is the most macroscopic viewing behavior, is an opposite concept to concentration, so audience rating or Gini concentration index is used as evidence to support fragmentation. Most previous research showed that as the channels increased channels resulted in a low distribution and coefficient of concentration in share of audience (Kang, N. and Cho, S. 2008; Webster 2005). Therefore, using Network analysis can predict that with the increase of channels the audience will watch greater variety of channels. However, the network concentration indexes can even explain a qualitative aspect of fragmentation, which cannot be identified with the degree of inequity using viewer ratings or indexes of concentration because it presents not only a degree of inequity, but also a form of inequity.

The details of fragmentation phenomenon can be understood through channel centrality. To understand the importance of channels the main focus was on viewer ratings of each channel. However, there is a limit to defining the role or status of each channel by simply using viewer ratings without a consideration of the relationships between channels. Therefore, it is necessary to examine the relative status in regard to the relationships between channels. The network centrality indexes (degree centrality, closeness centrality, and betweenness centrality) provide the information regarding the most favorable channel, the fastest channel in transmitting information, and the channel

placed in the core of transmission, by finding the channel located in the center of the network. When centrality of terrestrial channels gets lower, we can concretely identify the changes in the role or status of certain channels, which indicates where the centrality is moving to and accordingly how the role of channels is changing.

On the basis of the fragmented viewing pattern lies the polarization phenomenon in which viewers focus on only a few channels. This viewing pattern can be explained with the concept, called "channel repertory." In a multi-channel environment, the viewing pattern shows limited numbers of channel repertory, which means that viewers watch certain channels only, due to personal preferences, limited time and structure, lack of information about channels and programs, and so forth (Choi, Y. and Jang, S. 1998; Kang, N. and Cho, S. 2007; Lee, S. and Kim, K. 2001; Shim, M. 2005; Ferguson and Perse 1993; Heeter and Greenberg 1988; Yuan and Webster 2006). This phenomenon, called channel repertory occurs when an interrelationship between contents of channels is high and viewers use channels unequally according to their personal preferences (Webster and Wakshlag 1983; Webster 2005). Therefore, previous research has not specifically examined how the channel repertory is formed although it is suggested that the channel repertory is highly related to the channel content (Choi, Y. and Jang, S. 1998; Lee, S. and Kim, K. 2001; Heeter and Greenberg 1988; Webster 2005; Youn, S. 1994). This limitation is because previous studies simply focused on distribution of viewer ratings and thus excluded lower viewer rated channels because they could not perform statistical tests. As a result, they are unable to identify "small but loyal viewers," which Webster (2005) suggests is evidence of fragmentation. Therefore, it is necessary to investigate both "big and loyal viewers" who mainly use terrestrial channels and "small but loyal viewers" who choose channels according to their personal preference.

Research Questions

1. What is the effect of the increase in channels on the network structure between channels?
2. Does viewing pattern fragmentation change as channels increase? If so, how is it changed?
3. How is the centrality role of each channel changed as channels increase?

4. Is there a fragmentation phenomenon in viewing pattern as channels increase?
   4-1. Are there "big and loyal viewers" and "small but loyal viewers"?
   4-2. What are features of channel repertory that cause "big and loyal viewers" and "small but loyal viewers"?

IV. RESEARCH METHODS

1. Characteristics of Data

The most frequent criticism in the research of TV-viewing patterns is that research is performed through self-reported Survey. Collecting information regarding phenomenon such as the media using Recall Method like surveys has limitations in research validity and reliability. In particularly, as channels rapidly increase, it is difficult to recall every channel used or calculate hours of actual watching time. Data from viewer ratings, however, can be a meaningful and objective analytical tool because it indicates viewers' behaviors, such as the channels viewers choose to watch and the time viewers remain on a certain channel. For this reason, this research employs viewer ratings data using panels in order to examine the change in viewing patterns as channels increase. Data from panels controls other effects caused by variations because it uses specific samples. In addition, since data from panels measure precisely the change of viewing patterns due to increased channels, it is the most appropriate data for exploring change over time. The panel viewer ratings data from AGB Nielsen includes samples of 7 days from March 2004 (2,158 people) and April 2007 (2,912 people). 298 people who had viewing ratings collected in both 2004 and 2007 were selected as a final sample. The number of channels, which AGB Nielsen measured, had increased from 70 in 2004 to 85 in 2007, indicating it increased 15 channels in three years. In 2003, there were 60 channels, which means it was a smaller number of channels compared to 2004, so it seems to be a more appropriate sample than 2004. However, we sampled the 2004 data because 2003 had very small numbers of common panels that were kept until 2007, which could be used for sampling. In addition, sampling from 2007 is appropriate because channels did not

rapidly increase after 2007. Therefore, we investigated the viewing patterns of 15 increased channels by comparing the two years, 2004 and 2007.

Since viewer ratings data is usually documented every 15 minutes, we calculated the whole viewer ratings of a week after summing up daily ratings first. Thus, we employed the data, which is based on accumulative ratings of an individual viewer per week, and we used the data for the analysis to check whether the viewer ratings of a certain channel were true or not. However, when it comes to the ratings of channels, unlike ratings of programs, a special standard to gauge whether the ratings of channels were accurate or not was needed. First, we assumed that all channels had an equal chance of being chosen by viewers. This means that each channel required a minimum rating which was measured by each channel viewing time in a week divided by the whole numbers of channels. Then, by applying this standard, we assumed that viewers watched a certain channel when the channel has more than the minimum rating time (a week is divided by a whole numbers of channels). Also, we assumed that viewers did not watch a certain channel when the channel had less than the minimum rating time.

2. Data Analysis

Since viewer ratings data is two-mode data, multiplying viewers by ratings (viewers x ratings), it is necessary to change it to one-mode, multiplying a channel by a channel (a channel x a channel), in order to analyze the network between channels. Therefore, we implemented a network analysis after changing from two-mode to one-mode by using Ucinet 6.0.

First, the general structure of a whole network between channels was explored through spring embedding method. Spring embedding method is one of the ways to present the status between nodes. Locations of each node are not meaningful, but distances between nodes indicate their similarities. Both locations and distances are meaningful in MDS Method, but this method causes difficulty in understanding network structure when there are many nodes because the locations between nodes are fixed. Thus, Spring Embedding Method, which focuses on distances and disregards locations, is the most appropriate method to understand a whole network structure when there are many nodes because it helps explicate the network at a glance by

changing the locations of nodes.

To examine fragmentation of viewers, network concentration analysis was implemented. For the analysis of the network, density, degree concentration, closeness concentration, and betweenness concentration were used as indexes indicating inequality of channel usage. Higher density meant that channels were closely related to each other, so viewers used various channels. Degree concentration, closeness concentration, and betweenness concentration have a range from maximum one to minimum zero. Getting closer to 0 means higher concentration and getting closer to 1 is lower concentration. Degree concentration shows a tendency that viewers are concentrated in certain channels, and closeness concentration means concentration of the distance between networks. Betweenness concentration indicates concentration of channels that play a role as a broker. In other words, concentration shows one viewer played a central role while other viewers are on the periphery.

Degree centrality, closeness centrality, and betweenness centrality of network have been used to examine the changes in the role and status of channels. Degree centrality measures centrality of a certain node by summing up neighboring nodes, which are directly connected to a certain node. Closeness centrality measures centrality based on distances between nodes. The center node, which is decided by closeness centrality, is located the shortest distance from all other nodes. Betweenness centrality means that channels play a role as a mediator or broker in a network. The broker takes place between members of the whole network when there is some information flowing and exchanging even though the broker has low connectivity.

Polarization of viewing pattern and channel repertory can be examined through the concepts of "big and loyal" viewers' and "small but loyal viewers." Polarization and channel repertory can be perceived as a sub-group or partial-group of fragmentation, which has a homogenous viewing pattern. Thus, the factions method was used, which is a sub-group network analysis that analyzes a partial-group with homogenous interests. Faction method finds subgroup networks that are the most ideally separable. The method is a cluster analysis that distinguishes sub-groups that have the highest segmentation or possibility from each other.

Table 1. Network indexes representing the relationships between the channels and audience behaviors

Network indexes		The channels and audience behaviors
Density		An index to imply inequity of channel usage
centralization	Degree centralization	The tendency toward particular channels
	Closeness centralization	The concentration of the distance between channels
	Betweenness centralization	The concentration of channels that play a role of a broker
Centrality	Degree centrality	The channels that play the role of an herb-station and high information sharing
	Closeness centrality	The channels that play the role of the rapid information delivery and pursuit
	Betweenness centrality	The channels that play the role of a broker controlling communication and information flow
Sub-group networks		The set of channels which have homogenous viewing pattern

V. RESEARCH RESULTS

1. Characteristics and Changes in Network Structure of TV-Viewing Pattern

As the number of channels increased, we performed a Network Analysis on the viewing patterns of 298 panels in 2004 and 2007 to understand the changing viewing patterns. In the whole network, the nodes represent channels and the thickness of the connected lines represent the number of viewers. Using the spring embedding method, Figures 4 and 5 represent the network of channels using the distances between nodes that represent the status of the nodes. In 2004 from the 70 channels the 37 channels that did not meet the standard of organized viewing were excluded and 33 channels were formed into a network (33/70=0.47). In 2007, out of 85 channels, 36 were

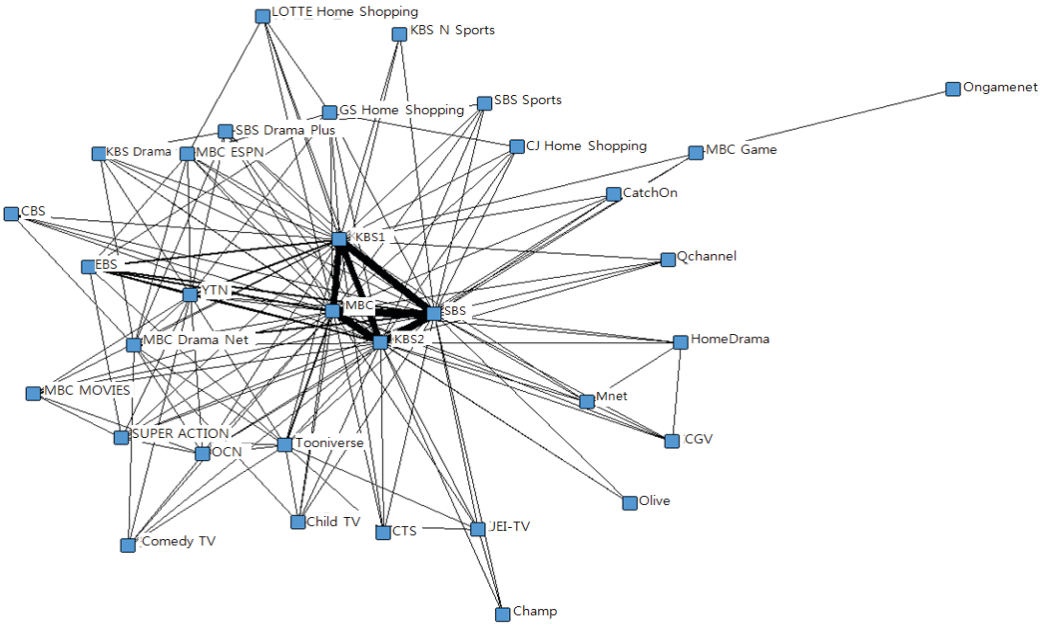

Figure 4. Network structure of TV-viewing pattern in 2004.

excluded and 49 channels formed the network (49/85=0.58). Analysis showed that as the number of channels increased the number of channels viewed both increased and became more diverse. Therefore, a multi-channel environment can satisfy viewers' diverse interest to some extent.

Looking at the structure of the whole network, we can see that the network is centered around the terrestrial channels and these channels form strong bonds with each other. Comparing 2007 to 2004, although the numbers of channels increased, the position and connectivity strength of terrestrial channels did not show a significant change. However, comparing 2007 to 2004, terrestrial related channels SBS-Drama-Plus, MBC-Drama have moved closer to terrestrial channels sharing a closer relationship. This demonstrates the unlimited evolution property of the network. As new channels enter the network, the audience selects channels with a similar preference. Therefore viewers who showed a strong preference to terrestrial channels moved to channels with similar properties as terrestrial channels and this lead to a link

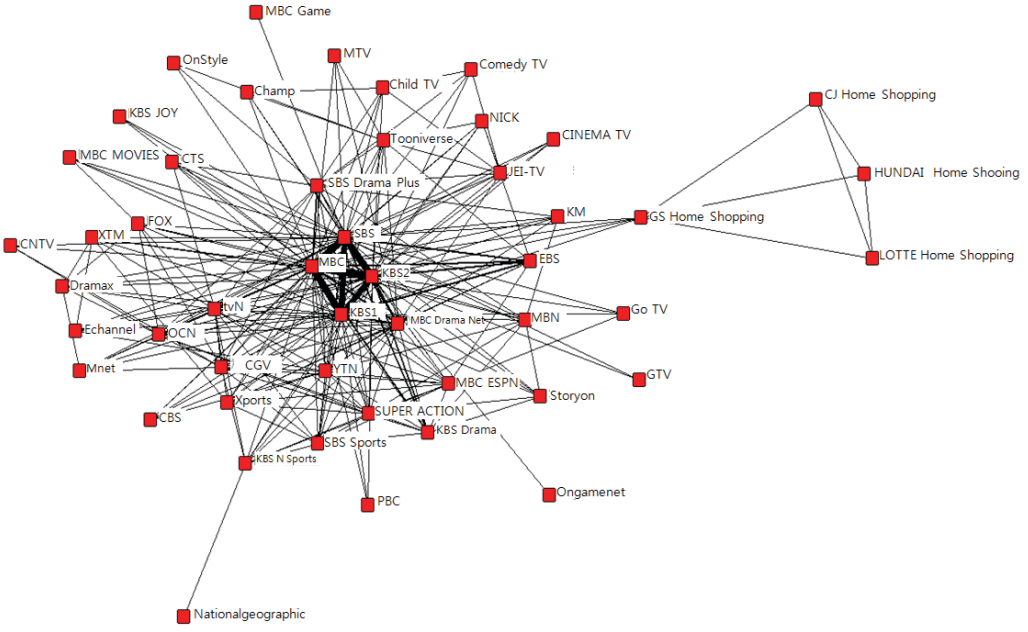

Figure 5. Network structure of TV-viewing pattern in 2007.

between terrestrial channels to channels related to these channels forming an expanded network. This scale-free network shows that a viewer's choice for channels are not random, but is based on their preference, indicating that channels are expanded on the extension of preference. Especially in 2004, viewers of game channels, such as MBC-Game-net and On-game-net did not view terrestrial channels. On the other hand, in 2007, it was the home-shopping channel viewers who did not watch terrestrial channels.

By looking at the overall structure of the network, we can understand the approximate behavior of viewers. However, since the network is complicatedly connected, trying to understand the characteristics of a network through only the network status has its limitations. Therefore, we did further analysis using indexes that will help us understand the network in detail.

Table 2. Network density and centralization

Time	Density	Degree	Closeness	Betweenness
2004	2.28(13.02)	10.10%	74.28%	19.80%
2007	1.10(42.38)	7.63%	66.15%	20.13%

2. Network Centralization and Fragmentation of TV-Viewing Patterns

To measure viewing inequality, the concepts of density and centralization were used. High inequality means that viewers are concentrated to a certain channel. Table 2 compares the viewing behavior of 2004 and 2007, using these indexes.

Density is represented by the connectivity of nodes, meaning that when channels are closely connected the density is high and when density is low, the channel connectivity is low. When we compare network density in 2004 and 2007, we learned that with the increase of channels in 2007, the density is two times lower than 2004. This indicates that as the channels increased, the viewers did not select channels evenly. However, since the relative density usually decreases as the number of nodes increases, we need to reinterpret this data using the centralization indexes. Density is determined by averaging the number of connected relationships, while degree, closeness, and betweenness are determined by understanding the concept of variation. Centralization refers to how much the whole network gets concentrated to the center of the network. Thus, when an interaction becomes concentrated to certain nodes, the centralization increases. On the other hand, when there are a variety of interactions between nodes this leads to low centralization. Therefore, the density and centralization basically have an inverse relationship.

When looking at the overall network centralization, both degree centralization and closeness centralization were lower in 2007 compared to 2004. Degree centralization was 10.10% in 2004 and decreased to 7.63% in 2007, while closeness centralization was 74.28% in 2004 and decreased to 66.15% in 2007. This indicates that concentration to specific channels decreased. Therefore, as the number of channels increased viewers moved to a variety of non-terrestrial channels. In conclusion, "fragmentation" phenomenon to other specialized or professional channels was strengthened.

However, in the case of betweenness centralization, 2007 was actually a bit higher compared to 2004. This means that the concentration of channels that played a role as brokers either increases or they newly appeared. The increased betweenness centralization, in spite of the decrease in connectivity and closeness centralization, indicates that the loss of concentration to terrestrial channels leads to a more dispersed viewing pattern, but also a higher concentration to some other channels. Figure 4 and Figure 5 show this phenomenon.

In the 2004 network structure, YTN, Tooniverse, OCN, MBC-Drama-Net seemed to play the role of broker channels. On the contrary, in 2007 network, additional channels, such as TVN, channel CGV, and KBS-Drama-Plus, became broker channels. Therefore, one can conclude that as channels increase, re-concentration is occurring to other channels other than the terrestrial channels. Re-concentration due to the broker channels seems to be the reason of decreased density.

3. Network Centrality and Changes in the Roles of Channels

Network centralization analysis showed that viewing which was focused to terrestrial channels is now spreading to other channels, leading to fragmentation and re-concentration to other channels. For further understanding of channels to which the re-concentration is occurring, we implemented network centrality analysis. To do this, we used degree, closeness and betweenness centrality. Table 3 shows that since there were different numbers of channels in 2004 and 2007, we used the standardized value that was divided by the total number of channels and ranked the top 20 channels' centrality.

Each centrality contains a different meaning. First, degree centrality directly uses the sum of the number of connected links between channels. Since the number of links depends on the number of viewers, degree centrality is the average of the links added on by viewers and has a similar concept as viewer ratings. Degree centrality is concentrated to the 4 terrestrial channels in both 2004 and 2007. Specifically, the order of viewers was MBC, SBS, KBS2, and KBS1 and this order did not change with the increase in channels. However, as channels increased, the degree centrality decreased,

Table 3. Channels and network centrality in 2004 and 2007

NrmDegree				nCloseness				nBetweenness			
2004		2007		2004		2007		2004		2007	
MBC	11.15	MBC	8.20	KBS2	94.12	MBC	85.71	KBS2	21.67	SBS	21.69
SBS	11.06	SBS	7.82	SBS	91.43	KBS2	84.21	SBS	19.73	KBS2	20.59
KBS2	10.72	KBS2	7.63	MBC	88.89	SBS	84.21	MBC	16.70	MBC	20.01
KBS1	9.42	KBS1	6.63	KBS1	82.05	KBS1	73.85	KBS1	11.92	GS Home shopping	11.97
EBS	2.19	MBC Drama Net	1.35	YTN	64.00	MBC Drama Net	60.76	MBC Game	6.25	KBS1	8.34
YTN	1.23	EBS	0.83	Tooniverse	61.54	tvN	60.76	YTN	1.45	KBSN Sports	4.17
MBC Drama Net	1.23	KBS Drama	0.83	MBC Drama Net	61.54	YTN	59.26	Tooniverse	1.15	SBS Drama Plus	1.70
Tooniverse	1.05	SBS Drama Plus	0.82	OCN	58.18	CGV	58.54	MBC Drama Net	1.07	MBC Drama Net	1.60
SUPER ACTION	0.80	OCN	0.68	EBS	57.14	SBS Drama Plus	57.83	GS Home shopping	0.29	tvN	1.33
OCN	0.75	YTN	0.68	GS Home shopping	57.14	SUPER ACTION	57.83	OCN	0.25	YTN	0.93
MBCESPN	0.73	tvN	0.62	MBCESPN	57.14	MBCESPN	57.14	MBCESPN	0.23	CGV	0.89
CTS	0.50	CGV	0.60	SUPER ACTION	57.14	SBS Sports	55.81	JEI-TV	0.20	Tooniverse	0.80
SBS Drama Plus	0.50	Tooniverse	0.58	SBS Drama Plus	56.14	OCN	55.17	EBS	0.13	MBCESPN	0.52
KBS Drama	0.50	MBC ESPN	0.57	Child TV	55.17	KBS Drama	55.17	SBS Drama Plus	0.12	SUPER ACTION	0.46
GS Home shopping	0.36	SUPER ACTION	0.48	KBS Drama	55.17	Tooniverse	54.55	Mnet	0.10	OCN	0.38
Child TV	0.32	SBS Sports	0.42	MBCM OVIES	55.17	Xports	54.55	SUPER ACTION	0.09	KBS Drama	0.18
MBC MOVIES	0.32	FOX	0.35	JEI-TV	54.24	KBSN Sports	53.93	Child TV	0.08	JEI-TV	0.17
SBS Sports	0.30	Xports	0.33	Mnet	54.24	MBN	53.33	CGV	0.00	Xports	0.14

indicating viewers moved from terrestrial channels to other channels. One difference that stands out is that drama channel viewers significantly increased from 2004 to 2007. Not only did degree centrality of drama channels related to terrestrial channels increase, but rankings also increased. Therefore, although viewers who watched terrestrial channels in 2004 showed fragmentation in 2007 they were re-centralizing to terrestrial channel related drama channels.

Closeness centrality, unlike degree centrality, takes into account all indirectly connected dots and directly connected dots and calculates centrality through the sum of the minimal distance between dots. Therefore, channels with high closeness centrality can approach other channels quickly and easily. In 2004, KBS2 had the highest closeness centrality, while in 2007 MBC was the highest; KBS1 had the lowest closeness centrality in both 2004 and 2007. This means that while viewers flipped through channels, they had a high chance of starting at MBC. Especially in 2007, drama and movie channels like MBC-Drama-Net, TVN, Channel-CGV, etc. had an increased closeness centrality compared to 2004.

Betweenness centrality depends on how good of a mediator role a node plays when forming a network with other nodes. Thus, channels with high betweenness centrality not only play a role in connecting channels with other channels but also disrupt the flow of information and viewing flows of other channels when this channel is lost or does not perform its role. In the case of betweenness Centrality KBS2 was the highest in 2004 and SBS was the highest in 2007. This leads us to speculate that there is a specific viewing pattern for viewers who watch SBS. Furthermore, in 2007, GS Home-Shopping, KBS-N Sports, and SBS-Drama-Channel had higher betweenness centrality. These channels play a role in connecting channels similar to themselves, which makes us predict a possibility that home-shopping, sports, and drama channels groups are being formed.

By summarizing the three centrality indexes, we learned that the biggest change in terrestrial broadcasting is that the influence of public broadcast company KBS decreased and the influence of MBC and SBS both increased. Also, in 2004, educational broadcasting, such as EBS, Children TV, Jaeneung Education had high centrality, but in 2007, drama, sports, home-shopping channels had high centrality. Therefore, as channels increase channel

consumption moved from education-oriented channels to entertainment-oriented channels.

4. Sub-group Network and Polarization of TV-viewing Pattern: Channel Repertory

By analyzing the network status and centrality, we learned that the channels centered around terrestrial channels consumption were now being dispersed to other channels, demonstrating fragmentation. During fragmentation, we learned how the channel status and functions changed. Next, a sub-group network analysis method known as fractions method was used in order to understand polarization, which the basis of fragmentation.

In the case of 2004, 8 sub-network groups were formed (fitness=220) and in 2007, 12 sub-network groups (fitness=352) were formed. Since there were more sub-network groups in 2007 compared to 2004, we learned that as the number of channels increased, polarization became more evident. The features of the 2004 sub-groups showed that there was a "large-but-loyal" group centralized around terrestrial channels and 7 "small, but loyal" groups. In particular, the terrestrial channel centered "large and loyal" group shared movie channels with the terrestrial channels. This means that a large number of viewers formed a channel repertory with terrestrial channels and movie channels. The sub-groups other than the terrestrial channel centered sub-groups were formed by channel repertories of similar content. This means the "small but loyal" groups were formed and centralized around channel contents. However, although channel viewing networks around similar content such as home-shopping or children-oriented channels are formed, when examining the sub-groups they do not have an intimate connection between content nor does the channel repertory show a strong connection for similar content.

In 2007, the relationship between content and channel repertory became clearer. As channels increased channel-viewing behavior centered around a particular content. The 12 sub-groups, which contained viewers of terrestrial viewers, showed a stronger connection and formed around similar content compared to 2004. This directly showed that channel viewing polarization has intensified. Viewers who only watch similar content, such as home-shopping,

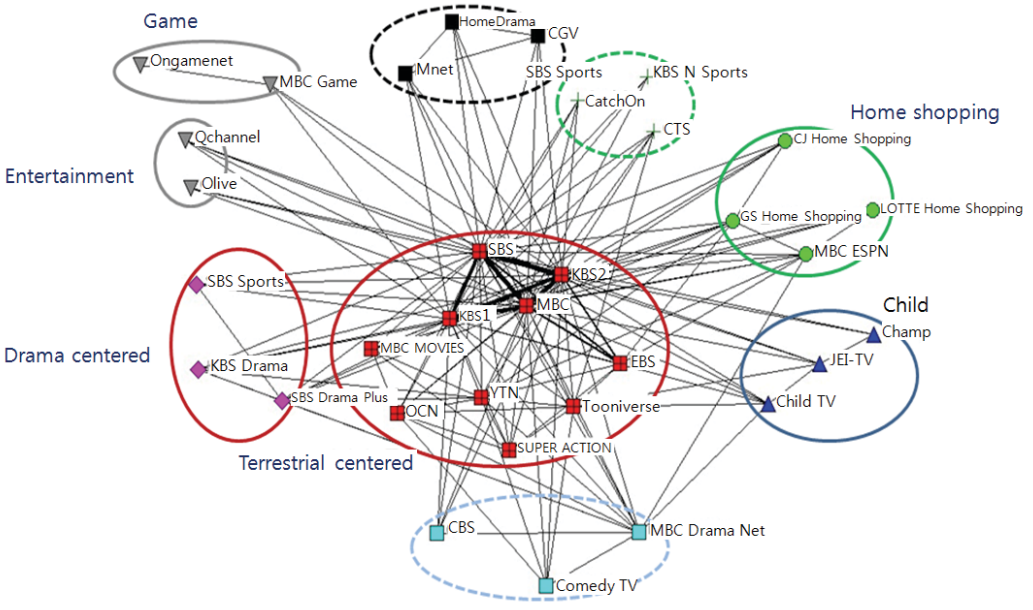

Figure 6. Sub-group network in 2004.

child-oriented, and movie channels have formed. Also, viewers who watch channels related to their hobby or interest, such as Go or specific religions have appeared. Unlike 2004, the viewers who watch terrestrial channels watched sports channels. One the thing that especially stands out from 2004 is that SBS viewers show a different channel viewing pattern compared to other terrestrial channel viewers. Major viewers of SBS also watch SBS-Drama-Channel and also gaming and child-oriented channels. This indicates that unlike other terrestrial channels, the SBS content-channel repertory is watched by younger viewers.

As we have shown in the centrality analysis, SBS and GS Home-Shopping showed high betweenness centrality, indicating that these channels play a role as broker channels. These results were further emphasized in sub-group network analysis. As seen in Figure 7, unlike other terrestrial channels, SBS plays a stepping-stone role in connecting all terrestrial channels, and GS-Home-Shopping plays a role in connecting home-shopping channels and terrestrial centered channels; GS-Home-Shopping nationwide uses the

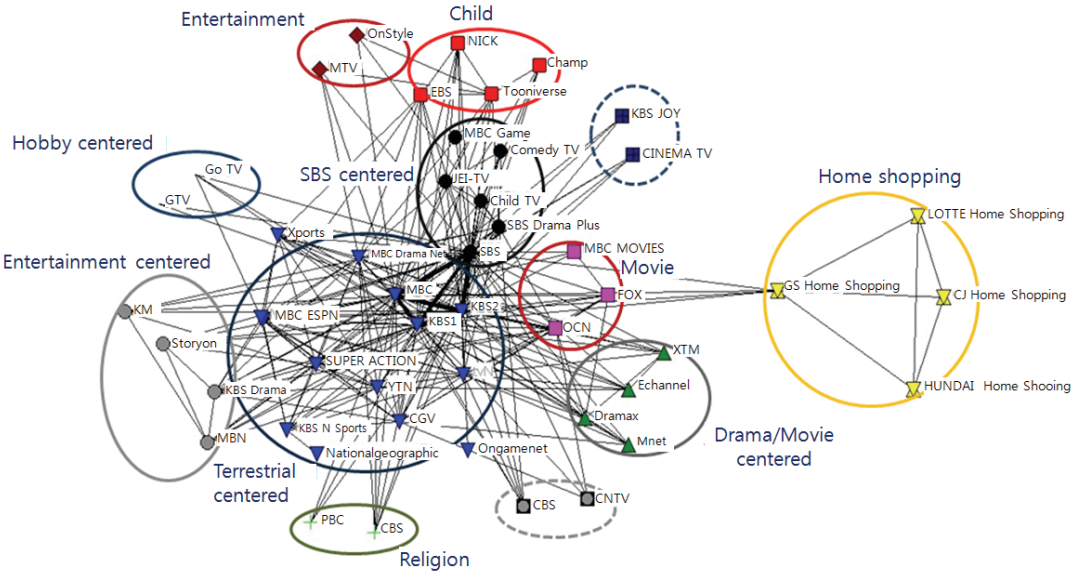

Figure 7. Sub-group network in 2007.

channel 10 bridging terrestrial channels. As a result, they make the most profit between home-shopping channels (*Hankyoreh* 2010).

VI. CONCLUSIONS AND IMPLICATIONS

This study used network analysis method to view fragmentation and polarization phenomenon of TV-viewing behaviors as a comprehensive phenomenon. This approach overcomes problems of previous studies that treat these phenomena independently. In other words, since fragmentation, centralization, polarization and channel repertory occur as a simultaneous phenomenon caused by current multi-channel environment, we must treat them as inter-related phenomena and not as independent concepts. Also since the watching-behavior of the audience structured a network between channels, we found using a Network Analysis was appropriate and efficient.

First of all, we analyzed the viewer ratings data, which consisted of 298 panels in 2004 and 2007 respectively, using network analysis. The benefit

of panel data was not only to secure the validity and credibility of data, but also to figure out the change of viewing patterns. By constructing a network structure of 33 (33/70 = .47) channels in 2004 and 49 (49/85 = .58) channels in 2007, we were able to conclude that as the number of channels increased viewers watched a greater variety of channels. We analyzed network centralization to find direct evidence of viewing fragmentation. The increase in professional and specialized channels resulted in lower degree centralization and closeness centralization, all leading to further fragmentation to multiple channels. However, betweenness centralization was higher in 2007 compared to 2004, but re-centralized to other channels other than terrestrial channels. The details of fragmentation on re-centralization were confirmed through centrality network analysis. In the case of degree centrality terrestrial channels were the highest in both 2004 and 2007. However, in 2007, terrestrial channel degree centrality was lower than 2004, indicating viewers moved from terrestrial to other channels. Although in 2007 the viewers moved to other channels compared to 2004, we learned that they did not disperse to all channels, but re-centralized to specialized channels that broadcast terrestrial channel dramas. In 2004, the closeness centrality was highest for KBS2, but MBC was the highest in 2007. Another characteristic of closeness centrality was that drama and movie specialized channels, such as MBC-Drama-Net and Channel-CGV, were higher in 2007. For betweenness centrality, KBS2 was the highest in 2004, but SBS was the highest in 2007. Most importantly, in 2007, GS Home-shopping and SBS-Drama channels had high betweenness centrality, indicating home shopping, sports, and drama-channel groups exist.

These three centrality indexes not only show the limitation of a simple viewer rating order, but also suggest the importance of the role and choice of channels. More specifically, they revealed that channels with the most viewers do not always have the largest influence. The ranking of degree centrality, which is similar to the concept of viewer ratings, does not coincide with either closeness centrality or betweenness centrality. This indicates that simply using viewer rating to judge influence only considers the limited function of the channels itself. Therefore, understanding relationships and roles between channels in a multi-channel era would be very beneficial for the new channels launching advertisements and communicating information.

Next, we examined the polarization phenomenon, which foregrounds fragmentation. In 2004, there were seven "small-but-loyal" groups and one "large-and-loyal group" centered on terrestrial channels. In 2007, there were eleven "small-but-loyal" groups and one "large-and-loyal" group. Especially in 2007, these sub-groups strongly formed channel repertories with channels with similar content, compared to 2004. Sub-group network analysis concluded that although there was an increase in channels, fragmentation was occurring as viewers dispersed to other channels and the viewers were not simply moving to other channels, but watching channels whose content was similar to their interest, leading to more polarization.

A multi-channel era will lead to more fragmentation and polarization and this will result in viewers taking in prejudiced information. Since people want to take in information that they want to hear and that matches with their ideals, broadcasting will eventually lose its original purpose of generalization and social integration. However, network analysis shows that even in a multi-channel era, such as 2007, the terrestrial channels are still drowning out other channels in general approachability and centralization. Therefore, the increase in viewer fragmentation and loss of social-integration proposed by Webster (2008) still seems to be premature. Instead, network analysis has shown that we need to exactly understand the role changes of channels and that securing variability in a multi- channel era is what will improve the welfare of future viewers.

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