Advertising in Duopoly Market

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(November 10, 2006)

Abstract

The paper presents the dynamics of consumer preferences over two competing products acting in duopoly market. The model presented compared the majority and minority rules as well as the modified Snazjd model in the Von Neumann neighborhood. We showed how important advertising in marketing a product is. We show that advertising should also consider the social structure simultaneously with the content of the advertisement and the understanding to the advertised product. Some theoretical explorations are discussed regarding to size of the market, evaluation of effect of the advertising, the types of the advertised products, and the social structure of which the product is marketed. We also draw some illustrative models to be improved as a further work.

Keywords: advertising, snazjd model, majority model, duopoly market.

1 Introduction

If you have a new product to be distributed in the market, you have to let the people know about it. Furthermore, if you want to let the market know that your product is better than the product distributed by your competitor, you must have the media to do it. Nowadays, a dominant and alternative way to do this is advertising. Advertising has been a part of the life of urban and modern life, and we know most products we consume to day are coming from the activity of this business channel.

The power of advertisement has even sometimes made people buy advertised product even at higher price. There is connection between the information that people need about product and profit-oriented company and it is advertisement that bridges this connection (see [3]).

Nonetheless, advertisement as a concept to penetrate a product information to the market cannot be solely seen in the sense of television commercials, street billboards, etc. We must see advertisement in a broader sense that includes the "word of mouth" among consumers or users and how they influence each other as a significant factor that makes a product gains success in marketing: social neighborhood and social network. Word of mouth of the goodness of one product holds a major role in the marketing before mass media such as newspaper, posters, radio, television and internet exist. Even today, word of mouth still prevails in product marketing. We are familiar with multi-level-marketing system where one company cut the conventional advertisement budget and allocate it to promotion via people's network.

The researches on marketing should see a lot of aspects in the relationship between the marketed products and the social dynamics and characteristics of the market, even further, in how a product is imaged in a consumer's mind. The concern of the fact that big company who owns bigger budget to campaign its product will always conquer the market and stand to be the single player in the market (monopoly) should end with the power of effective advertising (see for instance [2]). Finding the effectiveness of a product marketing should now involve the research on social neighborhood (and therefore, the micro interaction among them) and learn how collective preference emerged from such structure [15].

One of interesting method to see the advertising dynamics is by using the computer simulation. The computational based simulation, as introduced in the paper, has now become more popular in research as it brings many beneficials to the researchers and the sponsors of research and it is a very

interesting alternative in finding new scientific methods and theoretical exploration for analyzing social phenomena.

The paper begins with some recognitions to previous models that may have been widely accepted to understand the opinion formation. We understand that in sociological perspective, advertising must be related to the social agents' opinion formation. Here we emphasize the importance as outlined by the Sznajd Model and Majority-Minority Model. In the next section, we introduced an alternative point of view to see advertising as a process similar to catalytic process in which the two factors must be considered carefully in practice: the structure of social system and the content of information brought by the advertisement. Then we built a model to be simulated computationally that is inspired by the two models introduced before. The paper is ended with some discussions regarding the theoretical exploration and some lessons we may learn by observing the simulation result. Here, some further possible and challenging works are also presented.

2 Some Models on Opinion Dynamics

Sociological perspective on advertising would, however, talk about the formation of opinions among the social agents. People opinion may change because of social interaction and also may be transformed after they met with any advertised artifacts. By reviewing contemporary literatures on opinion dynamics, either an opinion changes because of the amount of brand campaign broadcasted in all over mass media or emerged from social neighborhood influence, we can simulate both computationally.

The computational model for opinion formation in political election has been a hot issue in some countries like Brazil and Poland using simple Ising spin-like model known as Sznajd Model [12], [13]. The modified voter model with different neighborhood in [11] even further shows pattern of clustering in Indonesian voters that implies a democratic election. In economy, Sznajd Model has also been used to model the dynamics of costumer's choice over two competing products by the help of advertising [14], [10]. It is also well understood in our social system that a majority opinion has powerful influence in changing one citizen's opinion. The latter phenomenon is another concern in Majority Rule Model and its modification model. We discuss Sznajd model and Majority-Minority model in detail below for those two models inspired the model we use here.

2.1 Sznajd Model

As it has been briefly discussed above, Sznajd model is a quite popular model in sociophysics and econophysics research communities. This model emphasizes the power of word of mouth in the spreading of ideas [12]. A story of a girl stares at something in the sky among the crowd is frequently used to illustrate this model. If the girl look to the sky among the crowd intensely and attractively just by herself, she might be considered as a freak or just want to catch other people's attention and the outcome is that people will not be interested in what she gazes about. But, when her friend comes and also stares to what the girl sees, the pair succeeds in making people around them interested enough and turn their heads to stare at what the girls are staring. Two or more people can influence other people better than a single fighter.

This model is inspired by the Ising spin model in physics and has been widely used to model the two-state dynamics in a population. In the Ising spin model, the up and down magnetic spins under condition of magnetic field showing dynamics that emerging particular magnetic properties: ferromagnetic, diamagnetic, or paramagnetic. In the Sznajd model, at initial fraction of two states and neighborhood rule applied, we can observe how a consensus (almost ordered condition) always be reached, be it sooner or later as a final steady state in the computational simulation (see [12], [16], [10], and [1]).

To model the advertising in duopoly market with this model, we could apply an external field that is transformed into marketing terminology of advertising level, so that we can observe the opinion dynamics over two competing advertised products while the consensus achieved in computational experiment prevails at the final state. In this model [14], the opinion formation is made up in virtual world formed by lattices so that observer could see the "interaction" of opinion formation emerged by the external field (advertising media) and the opinion formation in micro level. Here, we can observe such critical value computationally that theoretically can be denoted as the advertising level needed - as a function of initial fraction of particular product's consumers and the size of lattices - that will lead the whole system to faster steady state - where the consensus is achieved.

Another modification to this model was presented in [9] as an implementation of Sznajd rules in Ochrombel simplification (one site convinces four neighbors). Both models discovered that advertising is able to shed the

championship to the product that is initially a minority fraction and that the larger the lattice is the smaller the advertising amount needed to convince the whole market.

2.2 Majority-Minority Game

It is interesting to contrast the Sznajd model to the majority-rule [5]. Roughly speaking, this model adopt the rule in which an agent will follow the state of the majority in her neighborhood. The majority-minority (MM) model, nonetheless, reflect more realistic phenomena while we are talking about the opinion formation in social system. In this model, the neighborhood may be convinced by the minority group, but of course at smaller probability than the majority's - when there is strong or influential minority, it can also bring its neighborhood to their opinion [6]. Interestingly, the small number of charismatic revolutionary figures may arise and lead the system to follow them. Realistically, even in system where only accommodates majority rule in its micro-system, where the local majority opinion leads the system reaches consensus, the system shows rich dynamic behavior of opinion formation. It performs interesting characteristics that is dependant to initial fraction of opinion, the size of the lattice and the dimension of the lattice.

3 Advertisement as Social Catalysts

How can we see advertisement in forming public opinion? People recognize any ideas spreading in public by communicating and interacting with our neighbors. The micro interactions, somehow, lead social agents to state their stances about ideas, products, or any information. Advertisements that shown in public stages bring information about products to people, and since interaction holds a very important and crucial thing in social system, advertisement brings this information to micro-social interactions. This role is interestingly similar with catalysts in chemical reaction.

By general definition, a catalyst is any (chemical) substance that is able to accelerate a (chemical) reaction [7]. Taking the concept of accelerator to gaining equilibrium in a market, a convincing advertisement which can fasten the consumer to believe the product and hence, consume the product, is also called catalyst. The marketing pace should be slower if we only count on the conventional marketing. An advertising will affect the individual as much as

catalyst interact with the reactant in micro state and we see in macro level the system reaching equilibrium state where the advertised product is successful as the dominant product in the market. However, if the mechanism repeated over and over again in the neighborhood consumers for certain period of time, we would see the dynamical equilibrium in macro level, and at this point we could arrange a marketing strategy as we analyze from the simulation result.

Let A become the consumer of product "A" and B is the consumer of product "B", both are unexposed to any kind of form of media advertising except their initial choice over the product. As we set aside individual credibility of both consumers, when they both interacting each other, thus, there is fifty-fifty chance that consumer B is convinced and follow consumer A's choice and vice versa:

$$\begin{aligned} A + B &\xrightarrow{\text{p=50\%}} 2A \\ &\text{or} \\ A + B &\xrightarrow{\text{p=50\%}} 2B \end{aligned} \tag{1}$$

When we regard advertising as a media to inform a product to the consumer and a persuasive message to consume the product, the scale of advertising also can alter consumer to the advertised product in a more effective time. Just like the work of a catalyst in chemical reaction, a consumer A that is the one who is initially chose product A with an amount of advertising X bringing more facts or information about the goodness of product A can convince B more easily since there is tendency that a consumer tend to believe a more popular product (for their quality) (see [4]). In the "consumers reaction" below, the double arrow shows the faster the reaction to gain more followers when advertising is applied.

$$\begin{aligned} (A \cdots X) + B &\Rightarrow 2A + X \\ &\text{or} \\ A + (B \cdots X) &\Rightarrow 2B + X \end{aligned} \tag{2}$$

This is the micro-model that hypothetically occur among agents, and through the paper, we expect to be able to describe the dynamics of competition between two players in duopoly market by the means of media advertising in its big picture. We hypothesize that a company could optimize their product campaigning budget by analyzing the right time to put and pull advertising through computational experiment.

4 The Model

We are now stepping ahead from the assumption of micro-state as described above. We put advertisement in Sznajd model that can always win the advertised product when it passes the critical value of advertising. Our model inserts some rules in the Majority-Minority model as well as some modification of Sznajd model in certain condition. Here we want to observe the behavior of system with von Neumann neighborhood when the rules are applied and when advertising added into the system.

Assume there are two products compete in the market: product A and B. To ease the discussion, in our visualization we denote consumer of product A with "+" sign and B by "-". In real events we see that a consumer of product A one day may change her preference onto B in particular condition. In that frame of thinking, we would like to investigate the dynamics of consumer's preferences based on her neighborhood. In the neighborhood following Von Neumann neighborhood, the dynamics of this preference change arises from conditions that comply with four rules, they are:

Rule-1 If at time t, a lattice in the center representing an agent adopting product A is surrounded by four neighbors all adopting A then in the next round $(t + 1)$, the observed lattice will stay of being adopting A with probability as unity. This is relevant to the homogeneous society that tends to have strong bond in maintaining their stance for long period of time. Obviously, this rule is accommodated in majority rule.

Rule-2 In this rule we adopt the Majority-Minority rule of MM model. Here the dynamics of opinion formation ruled by majority rule but also accommodated the probability where the charismatic agent that is a local minority can also persuade her neighbors to follow. If the lattice that adopts A is surrounded by four neighbors who are all adopting B, then the lattice will have probability p (near 1) to change her stance into adopting B. There is also $1 - p$ probability for the minority to persuade and may change their neighbor's opinion. Although so, the probability could be relatively very small.

Rule-3 In a condition where the number of minority is larger, the probability $1 - p$ for the local minority to change their neighbor's opinion is also larger. In case of two identical lattices adopting the same opinion, they will induce their neighbor also to change into their opinion. Rule-1 to

-4 are introduced in the majority-minority model and especially rule-3 where the minor of minimum two lattices convincing other neighbor is resembling the rule in Sznajd model [14].

Rule-4 Somehow when one has equal number of neighbors share equally different opinion, say two neighbors adopt A, and the other two adopt B; she will be in frustration condition. She does not know what to do and it is saver commonly to stay the same with her previous stance. Let us call it micro-systemic frustration condition.

As a series of advertisement enter a society, the dynamics of opinion formation becomes interesting. Conventionally, it is well understood that when someone with strong evidence about wellness of a product speaks to the neighbors then they will tend to believe her even though she is a minority. In the worst case, there could be some sort of 'frustration' also when majority meet the strong (advertised) minority. Both have equally strong probability to influence each other or to stay in their position in the near future. When we meet this situation, we can see the dynamics of opinion change by the influence of how strong the resources of the media so that they are convincing enough to bring more evidences to change people's opinion. Here the rule-4 will depend on media parameter c that is calculated from equation 3 and 4:

$$c_i^A = \sum_{n=1}^{4} \phi_n^A \tag{3}$$

and so with the case for agent that adopts B will have credibility equals to

$$c_i^B = \sum_{n=1}^{4} \phi_n^B \tag{4}$$

If only the total credibility of A is larger than the total credibility of B, then the frustration condition (say F) will change into all adopting A. And so does the case for B; if only the total credibility of B is larger than the total credibility of A, the frustration condition leads to all adopting B. When the frustrated cell $F = A$, if only the credibility of other two neighbors adopting A equals or is larger, the cell will stay in adopting A and when the credibility is weaker, they will fail to maintain the frustrated cell to keep her

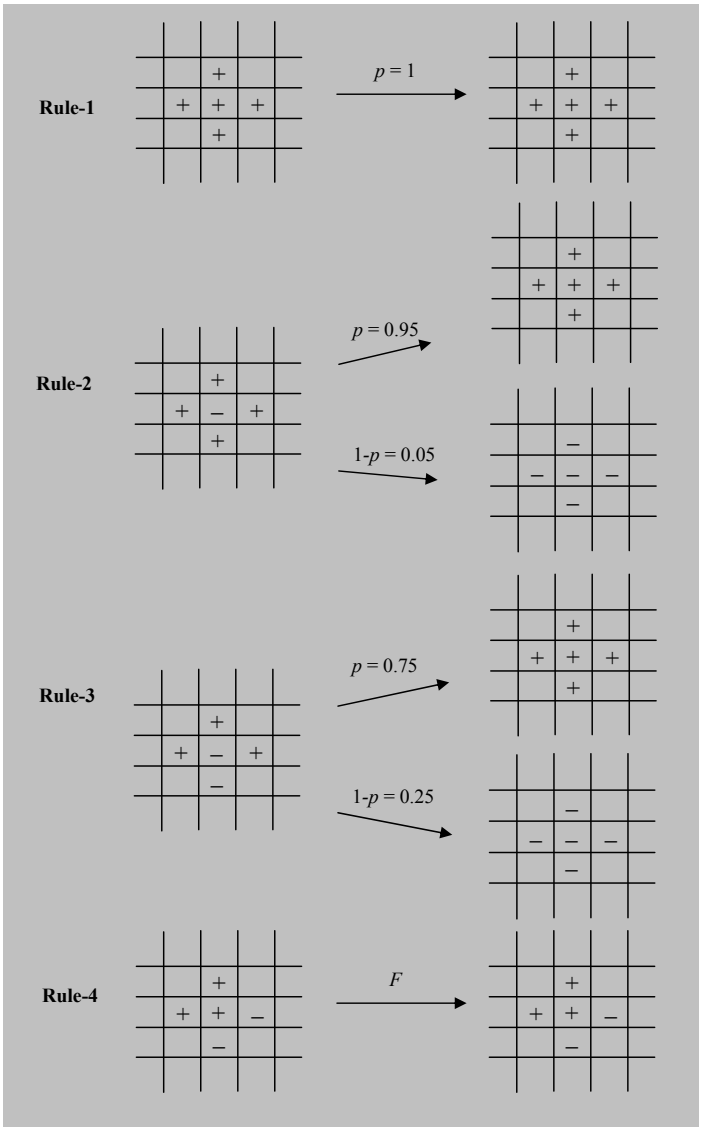

Figure 1: (**Rule-1**) Following the majority rule, the center lattice tend to stay in the local majority opinion (**Rule-2**) When someone adopts different stance other than all of respective neighbors, the probability to follow majority is much larger, however there is a small probability for a specific lattice to maintain her stance or even to induce her neighbors (**Rule-3**) Beside the majority has greater chance to induce other two, there is also probability for the two identical neighbors to convince the three neighbors according to Sznajd rule (**Rule-4**) In micro-systemic frustration, the center lattice will be confused and prefer to stay with her previous stance. However, when advertisement is put into account, the case will be very different.

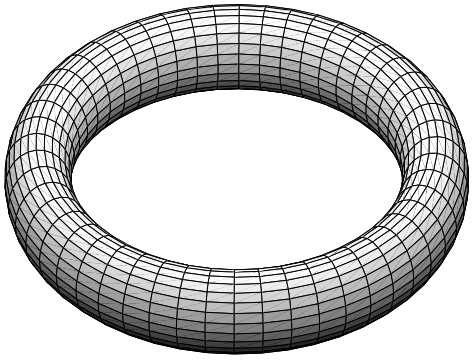

Figure 2: The virtual world of neighborhood lattices in advertising model that forms the structure of torus

stance and in turn, change in to adopting B. Mathematically we can write the conditions as:

$$\begin{array}{c} for\ F = A, F \to A\ iff\ c^A \geq c^B \\ F \to B\ iff\ c^A < c^B \end{array} \tag{5}$$

and vice versa to the case when the frustrated lattice is currently adopting B $(F = B)$,

$$\begin{array}{c} for\ F = B, F \to B\ iff\ c^B \geq c^A \\ F \to A\ iff\ c^B < c^A \end{array} \tag{6}$$

To find out how the big picture of the system is, we build a computational virtual world where the consumers are represented as lattices and grids in two-dimensional world. Furthermore, the lowest grids are pasted to the highest grids so that the neighborhood of the lowest grids are also affected by the condition of neighborhood in the highest grids, and so does the left grids meet the right grids showing the same behavior of their neighborhoods. Simply, in three dimensional view, the world is a torus.

In the simulation, we apply random sequential updating in determining the start up lattice of each iteration. At each simulation time, we pick one

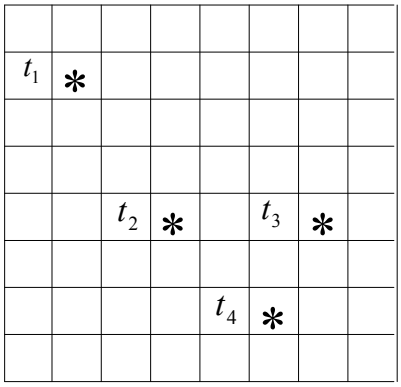

Figure 3: In the square lattice above, the square shows the initial lattice chosen randomly at different simulation time (iteration). Then the start up lattice evaluates the neighbor's opinion, following the start up lattice decides to change or not her opinion based on the given rules.

start up lattice randomly, and then the neighbors of the lattice will respond to the start up lattice and vice versa according to the four rules. The whole society represented by square lattice L x L and the dynamics is observed in two-dimensional lattice.

5 Simulation Results & Discussions

By using the algorithm explain above, we build computer simulation to do some experiments in order to be able to test some of our hypothesis about the effect of advertising between two competing products. Thus, we conducted series of experiments to see how the effect of advertising works onto the system which is described as a 2-dimensional lattices with certain size with von Neumann neighborhood that obeys the rules above. The experiment uses the JAVA Swarm Program for simulations and applies random sequential updating. The platform of the simulation is shown in figure 4.

Experiments we do in this computational platform is using the lattice sized 25 x 25 and 30 x 30 without closing the possibilities that we can vary the size of the lattice. We choose those sizes by realizing that the bigger the lattice the longer simulation would take and we will not take the risk of not observing the consensus may arise.

The first experiment is by running the simulation with and without any

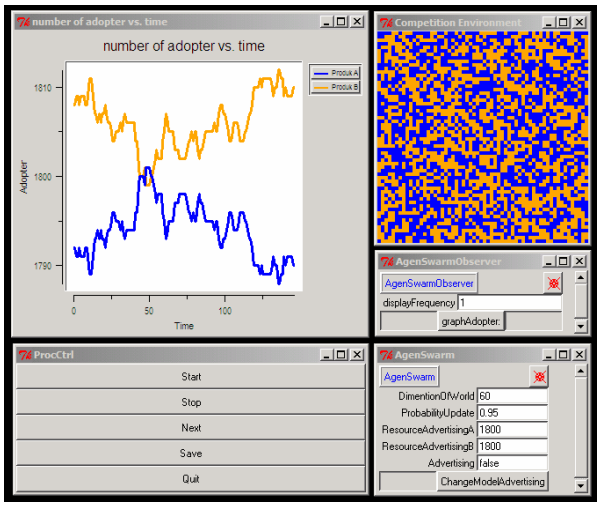

Figure 4: The algorithm was implemented as agent-based modeling in Java-Swarm in which we can change properties of the system to see dynamically the pattern emerged from our hypotheses.

advertising available. As discussed previously, referring to figure 1, we run the program by using probability to change as follows: *Rule-1*: $p = 1$, *Rule-2*: $p = 0.95$ thus $1 - p = 0.05$, *Rule-3*: $p = 0.75$ thus $1 - p = 0.25$, and *Rule-4*: $p = 0.5$.

As also discovered in slightly different perspectives and purposes in [14], we could see in figure 5 that advertising plays a very important role on transforming the whole system to meet the consensus. Here we can see a clear conjecture that as we see a lot of local parties selling fried chicken beside the sub-urban streets in Indonesia, they will never be able to compete with professional franchise fried chicken seller, like McDonalds or Kentucky Fried Chicken (KFC) for instance, since both latter parties use advertising very actively and intensely. However, in big picture, the competition of McDonalds and KFC can also be seen as competition of duopoly market in some cities throughout the country. Here, the dynamical optimization of the advertisement will however also play an important role. The influence of advertising when injected into the system, generally give strong impact in bringing out the product win the competition. However, if we talk about absolute winning that is when all the system adopts one uniform choice of product A or B (or in Sznajd model known as consensus) the time to reach

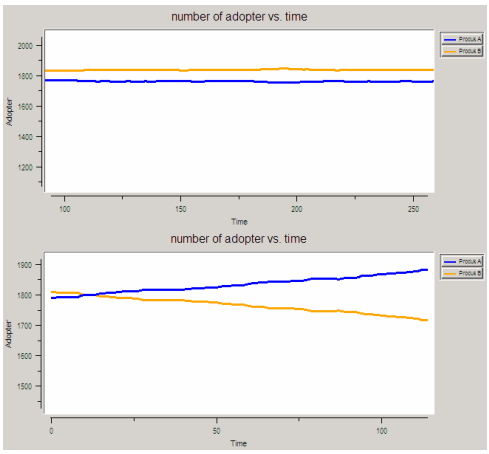

Figure 5: The result of the simulation with (*below*) and without (*above*) the advertising.

consensus rises as the system size (world) increases.

Here, we meet another next interesting theoretical question that is how much and how fast level of advertising needed to beat the market while our competitor do not use any advertising at all. Figure 6 shows this. We try the scenario with two different size of lattices and interestingly it shows gradual changes in the time needed and in the magnitude of advertising level needed to beat un-advertised competitor. It has become a kind of common sense that the bigger the size of the market, the longer time needed to conquer our competitor. But seemingly counter to our common understanding, the bigger the size of the market, it takes longer to beat the market with small addition to the level of advertising used. Here we can intuitively say that as the resource used for advertising is bigger, the longer a firm must wait to see the effect of the advertising. In some cases of market with relatively bigger size of market, the addition of advertising resource can give different time to evaluate.

What we want to see further from the series of our experiment is the effect of advertising in duopoly market by contrasting the two models describing in the beginning of the paper. In this session of experiment, we made a modification to rule-2. The value of p is changed to be various on each session. The bigger the value of p, thus the rule will be closer to (somehow) the minority or likely the Sznajd model and vice versa, the smaller it is, the closer to the majority model.

The experiment to see this is just similar with the recent one. The differ-

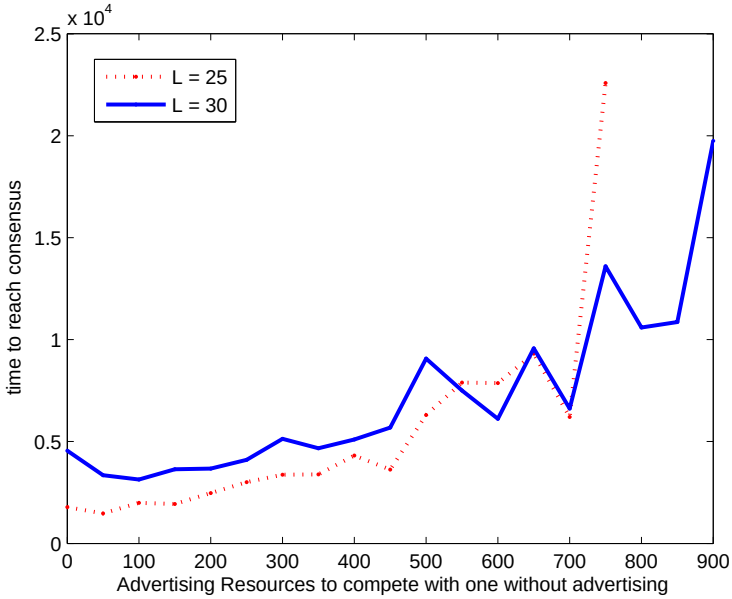

Figure 6: How much and how long would it take to beat the un-advertised product in the market?

ence is that we want to see two extreme situations of the micro-properties. As we see in figure 7, the full majority rule is much slower to meet the consensus relative to the one that we have modified to be closer to the minority rule or in some respects the Sznajd model. We should note that when the value of p is minimized, the virtual world of which not more than 2000 agents should not meet any consensus no more in our duopoly world. Thus, since the interpretation of the minority rule is that there is particular situation where minority can convince the majority in her neighborhood, then we can say respect to a product, the individual choices and preferences to it, the faster effect of advertising than the regular one.

We realize that there are some products that the power of information in advertising is so powerful be it very informative that individual can even use it to convince others, e.g.: some technological artifacts with specific sophistication in features or innovation. Here is the case, that in this model, we can "read" further properties of the competitive products that is being analyzed. Not all of product should be regarded the same handling respect to the level of advertising being actualized. Comprehensive work is somehow needed to understand how to manage the resources used to advertise by

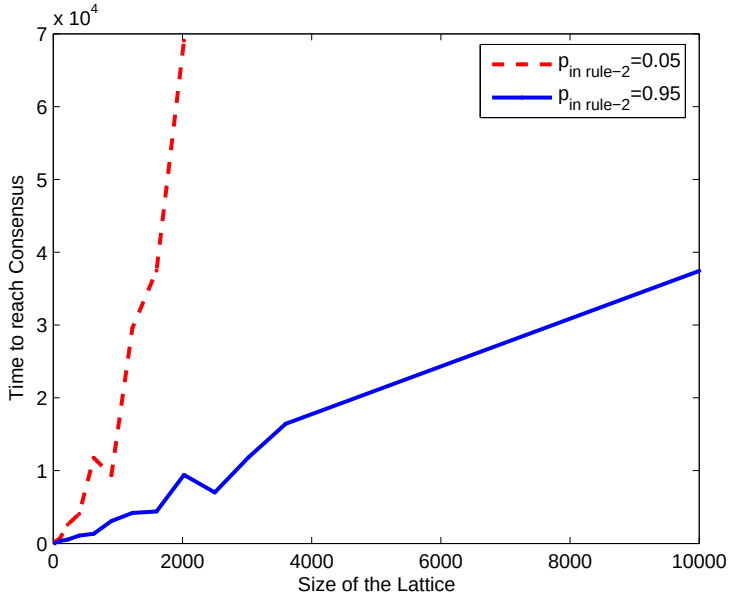

Figure 7: Two extremes: the minority seemingly may convince neighbors versus the "pressure" of majority in neighborhood to an agent to adopt a product.

regarding the type of the product and how the product interact with the consumer.

Eventually, we would like to see how the probability changes (in rule-2) gives the effect to the consensus met. In this experiment we varies the value of p used in rule-2 and see how long the advertised product beat the unadvertised one. The result is shown in figure 8.

As we see in the figure, we can see clearly now that if we see the probability of majority "pushes" the agent or the minority convinces the neighbors as things that can reflect the types or characters inherent in certain products to be advertised as previously discussed, thus the more sophisticated a product to be advertised or the more informative an advertising is made, the faster the consensus is met. As a matter of fact, this is very plausible since the function of advertising as a medium to inform things has synergetically met the way people interact upon which agents place their choices. In fact, this is the task on any model of effective management of advertising: how to cope with these two factors in the exact balance and efficiency.

We can also put evaluation into both advertised product as in the real

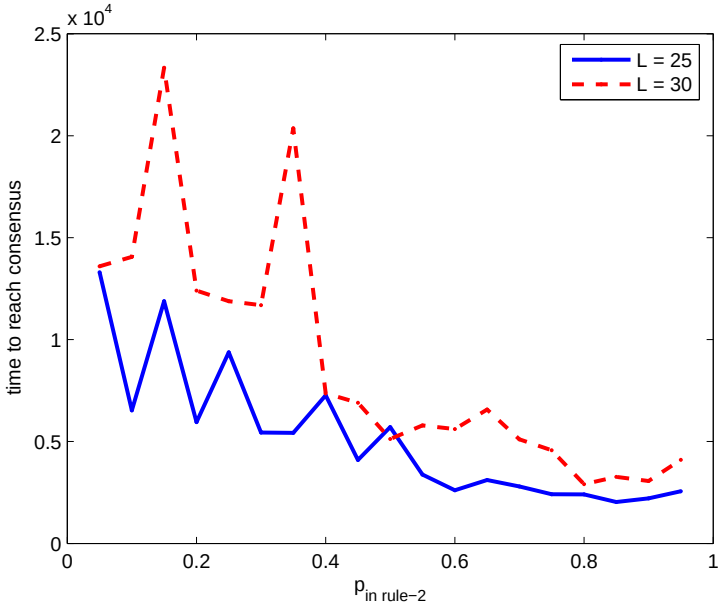

Figure 8: The more informative an advertising is, the faster it gets the consensus over un-advertised product.

retail-market in a simulation of a toy model. We see that optimization of marketing comes to the efficiency of the firm's budgeting. To implement this, we do some changes in our rule regarding to the "budget allocation" of the respective firm used as resource for advertising.

The first two rules are just the same with the one we use previously as depicted in figure 1. We change the rule-3 so that we have

$$p^A = \frac{1}{2}(p + \frac{c_i A}{c_i A + c_i B}) \tag{7}$$

and

$$p^A = \frac{1}{2}((1-p) + \frac{c_i B}{c_i A + c_i B}) \tag{8}$$

thus,

$$p = \frac{p^A}{p^A + p^B} \tag{9}$$

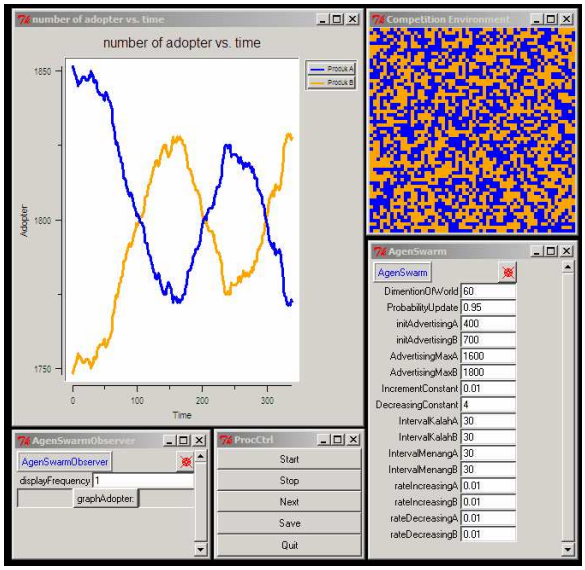

Figure 9: Further model to be advanced is a system within the two firms dynamically could change their level of advertising as a response to its achievement over time, over its competitor.

In return, the frustrated rule-4 should then be decided according the values of c_i^A and c_i^B: which one is bigger relative to each other.

Furthermore, if one product loses in the first $\Delta\tau_1$ iterations, the company would tend to increase its advertising resource by particular non-linear function. And for the company who always wins in its first $\Delta\tau_2$ iterations, it would think to safe some money by reducing their level of advertising in also certain non-linear function. In our simulation, we took for example the logarithmic and exponential function to show that the reducing and adding of the advertising resources is not really linear nor very sudden over time.

The yielded computational simulation is depicted in figure 9. It is obvious that there emerged interesting dynamical ups and downs of the products in the duopoly market. At one occasion, product A may conquer the market but as the advertising level of the product B is added by the respective company, and as the company A felt alright to step-by-step reduce the advertising resources in order to gain company's optimum budgeting, the product B could rise and not impossible become the major product used by agents. Specifically and carefully, this issue has been analyzed in [8].

This could be the further work opened in this paper as an implementation

conjectured by the simulation results and theoretical exploration we discussed previously. Some other additions to enrich the model can refer to some recent works on networks, memory, adaptability, and heterogeneity of agents, and moreover to the dynamical analysis to N-poly markets.

In our model, the agents left zero intelligent to see the simple dynamic of the agent's preference behavior. In advanced, memory hold an important role for agent in choosing product, as an agent learns from previous experience or neighbor's previous experience about a product. Beside close neighborhood, at some extent, we should also consider the social network of the consumers. It is hypothesized that individual with high rank in social network could have greater influence in opinion formation [17]. That would indicate the similar effect in the case of product preferences.

The way an opinion dominates the social system will also remind us of how a political opinion can change direction of opinion in certain community, or in general, how an idea evolves and becomes dominant opinion or at extreme level, consensus, can emerge in memetic fashion from complex adaptive social system is a kind of certainty to become another interest of further works.

6 Concluding remarks

We show the relatedness of Sznajd Model and Majority-Minority Model as two models that have been well-known to understand the opinion formation, and some cases, advertising. We modify some of the rules introduced in those models and build our own model by realizing that advertising should see two factors must be considered carefully in practice: *the first*, the structure of social system in which social agents interact one another and there is an obvious and inevitable influence between an agent with her neighbor and vice versa. *The second* is the information brought by the advertising itself. Advertisement is supposed to convey any information that can attract consumers to adopt certain products or any cultural objects. We propose that the process of opinion formation in the specific case of advertising can be seen like the activity of the catalyst in chemical reaction.

From the model we do series of experiments that we propose to be a kind of theoretical exploration enriching the study of marketing and advertising in general. Injecting advertisement to the social system is an effective way to convey persuasive information about a product, and it is very easy for a company with enough resources to conquer the market while the competitor(s)

do not use advertising at all.

We can use this model to study the behavior of the competitive duopoly market over media advertising. The model we propose shows rich dynamics behavior in duopoly market. At small lattices, the consensus time is readily observed and increase as the lattice size increase in non-linear manner. The majority rule dominates in reaching steady state (total consensus) far stronger than the minority rule in term of consensus time. In duopoly competition through media advertising, it is important to note that the more advertised product the more likely it win any competition in the market.

There are still interesting behaviors can be revealed from the system that applies this model. From our simulation, we can intuitively say that as the resource used for advertising is bigger, the longer a firm must wait to see the effect of the advertising. The effect of advertising is seemingly uncertain and this has become a part of the complexity in which this problem laid upon: in its design, implementation, and evaluation.

From other experiments, we show that individuality in decision to adopt any marketed product (whether it is caused by the sophistication of the product's innovation or the inherent micro-social properties) should be put into account when we design the marketing and advertising strategy.

Eventually, we also show a snapshot of some possible further works to be advanced ahead based on results presented in this paper. In some other perspectives, this model is, in fact, can be used to observe and understand other phenomena we find in daily social and cultural system, e.g.: political system, and furthermore build an evolutionary model enriched by a lot of properties and characteristics recently discovered in social complexity. Those left as further and challenging works in the future.

7 Acknowledgement

Author thanks Deni Khanafiah for implementation of the model to Swarm, colleagues in Bandung Fe Institute for their support and discussions, and Surya Research International for financial support during the period of the research. The paper is written with the remembrance of Tiktik Dewi Sartika.

References

[1] Chang, I. (2001). "Sznajd Sociophysics Model on a Triangular Lattice". *International Journal of Modern Physics C* 12(10):1509-12.

[2] Fershtman, C. and Muller, E. (1993). "The Benefits of Being Small: Duopolistic Competition with Market Segmentation". *Review of Industrial Organization* 8:101-11. Kluwer Academic Publishers.

[3] Fog, A. (1999). *Cultural Selection*. Kluwer Academic Publisher.

[4] Fog. A. (2004). *The supposed and the real role of mass media in modern democracy*. Working Paper. Published online: http://www.agner.org/cultsel/mediacrisis.pdf.

[5] Krapivsky, P. L. and Redner, S. (2003). "Dynamics of Majority Rule in Two-State Interacting Spin Systems". *Physical Review Letter* 90:238701

[6] Mobilia, M. and Redner, S. (2003). "Majority versus minority dynamics: Phase transition in an interacting two-state spin system". *Physical Review E* 68:046106

[7] Nedea, S. (2003). *Analysis and simulation of Catalytic Reactions*. IPA Dissertation Series 2003-06. UniversiteitsDrukkerij, Eindhoven.

[8] Prasad, A. and Sethi, S. P. (2004). "Competitive Advertising under Uncertainty: A Stochastic Differential Game Approach". *Journal of Optimization Theory and Applications* 123(1):163-85. Kluwer Academic Publisher.

[9] Schulze, C. (2002). "Advertising effects in Sznajd marketing model". *International Journal of Modern Physics C* 14(1).

[10] Schulze, C. (2004). "Long-range interactions in Sznajd consensus". *Physica A* 324(3):717-22.

[11] Situngkir, H. and Surya, Y. (2004). *Democracy at the Edge of Chaos*. Working Paper Series WPQ2004. Bandung Fe Institute.

[12] Stauffer, Dietrich (2001). "Monte Carlo simulation of Sznajd models". *Journal of Artificial Societies and Social Simulation* 5(1). URL: http://www.soc.surrey.ac.uk/JASSS/5/1/4

[13] Stauffer, D. (2003). *How many different parties can join one stable government?*. e-print arXiv:cond-mat/0307352.

[14] Sznajd-Weron K, and Weron R. (2003). "How effective is advertising in duopoly markets?". *Physica A* 324:437-44.

[15] Suroso, R. (2003). *Marketing, antara teori dan praktik*. Working Paper Series WPL2003 Bandung Fe Institute.

[16] Sznajd-Weron, K. (2004). "On controlling simple dynamics by a disagreement function". *Physical Review E* 66:046131.

[17] Wu, F. and Huberman, B. A. (2006). *Social Structure and Opinion Formation*. Research Paper HP-Labs. URL: http://www.hpl.hp.com/research/idl/papers/opinions/opinions.pdf