< MA Thesis (2001) - Abridged version >

Spatial Voting Models and Their Applicability to Korean Election

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ABSTRACT

Voting is an indispensible and important mechanism designed to enable for people to participate in politics in a democratic society. It is a choice among given alternatives that are affected by information. So, models for analyzing political agents in the voting mechanism should consider the uncertainty factor.

My thesis uses 'the spatial model' for analyzing the voting mechanism. The spatial model, which was initially introduced in economics, was applied by A. Downs to politics on a full-scale basis. This traditional spatial model emphasized proximity between alternatives. According to this model, if ideological distance between a voter and a candidate in an election is closer than the other candidates, the voter will support the candidate. This is why this model is called the 'proximity model'. Although this model is theoretically important, it is subject to many limits when applied to empirical analysis because the proximity model is based on unrealistic assumptions such as those voters perceive detailed information on candidates. But

there is not enough information available in the actual election process.

The 'directional model' was introduced as a corrective for the unrealistic assumptions of the proximity model. This model claims that a voter is under uncertainty, which only has little information about given issues. But the voter can get available information on the pro and con alternatives that candidates suggest. So, 'voter's utility' is determined by the direction of the alternatives. In Directional models, the 'matthews model' emphasized only direction and the 'Rabinowitz and Macdonald model(RM model)' emphasized intensity as well as direction. These directional models were based on symbolic politics. It changed politicians' role of merely the carrier of voters' opinions into that of the leader of their opinions in the spatial model. But the RM model, which has been known to have a good applicability to actual politics, is also criticized it's applicability. Compared with the proximity model, the problem of the in terms of its RM model lies in the unrealistic result that consists in overestimating utilities of extreme candidates. Rabinowitz and Macdonald suggested a region of acceptability as a solution to the problem. However, this modification could not succeed because of its 'ad hoc' characteristics.

To solve the theoretical problems of the RM model and to analyze various voting behaviors, T. Iversen suggested a 'mixed model'. His mixed model used a private region of acceptability to solve the problems of the RM model. This model used the logic of the proximity model in order to obtain a good level of applicability. The proximity model is indispensable to the direction model. Through this mixed model, the spatial model can take into account more various voting behaviors.

S. MerrillⅢ and B. Grofman added the matthews model to Iversen model. Each model is mixed by two parameters. One consists in connecting the matthews model and the RM model, and the other consists in connecting the directional model and the proximity model. The parameters, which are estimated through a regression analysis, may show the effect of issues that each model explains
My thesis points out that the proximity model, the directional model, and the Mixed model are regarded as three kinds of spatial models, in that these models add an uncertainty factor to the traditional spatial model.
Unlike Western countries, there haven't been many empirical analyses of spatial models in Korea. Therefore it is difficult to find designed surveys to test the spatial models. Because of it, The empirical test of these spatial models is experimental in My thesis

My thesis uses a survey conducted for the 1997 presidential election in order to test these spatial models and tests issues like ideology and region. The result of my empirical analysis reveals that Ideological issue effect appears low and that of the regional issue effect appears relatively high. Although the explanation capacity of each model is limited, the directional model, especially the matthews model, has a stronger capacity for explaining voting behaviors as based on the issues than other models. It is disappointing that the mixed model could not be applied to this

presidential Election.
Through the result of this empirical analysis, this thesis claims that voters' behaviors and utilities in Korea are mainly affected by the direction, which shows that Korean voters only have little information available when they choose their candidates.

Keywords: Election, Voting Behavior, Uncertainty, Proximity model, Directional model, Matthews model, Mixed model, A. Downs, Presidential Election in 1997

Ⅰ. Introduction

In modern politics, the researches about voting can be roughly categorized institutions and behaviors. This essay is focusing on the latter.
The researches about voting behavior analyze responses or influences of an individual or group about political activities. These researches also can be divided by two different types : Social psychological method and Rational choice method

In social psychological method, European countries and United States have different patterns. While a social partisanship caused by cleavage in societies affects political choices in European countries, a partisan identification plays a critical role in political decision of voters.

Unlike social psychological method, rational choice theory emphasizes voters want to maximize their utilities through political choice like in market.

It is difficult to categorize these two methods as totally different theories. It can be thought that voters' attachment which is a critical factor to influence political choices in social psychological method is also an important factor related with preferences of voters in rational choice method. Therefore the partisan identification in U.S. election studies can be analyzed that voters in limited information about voting, or uncertain circumstances, choose the same party which represented their interests. By doing this, voters rationally choose to maximize their utility, and these choices can be seen as the partisan identification. This thesis follows this rational choice method.

I will focus on the mechanism about voting behaviors as expressions of an individual's preferences. Anthony Downs' the spatial model is the representative one in this mechanism. By his theory, owing to uncertainty in voting, ideology plays an important role as a proxy to inform voters about every issue. He put certainty on perceiving ideology for voters, but real voting has more uncertainty including ideology. Even though he did not overlook this uncertainty, this was not controlled in his model. Because of it, his theory has received many criticisms to apply to analyze real elections (Stokes 1963 ; Matthews 1979 ; Rabinowitz and Macdonald 1989 ; Green and Shapiro 1994 ; Iversen 1994)

To tackle this problem, how to control uncertainty in real voting, many models have been suggested. These alternatives, based on Downsian model, can be characterized by the way to control uncertainty.

In my thesis, first of all, I will review the differences among various spatial models including Downsian model. These spatial models have tried to apply real voting studies in USA, European countries, and South American countries, and provided many important contributions to election studies. I will also try to apply these models to Korean election, and select an appropriate model.

Ⅱ. Spatial Model

1. Traditional spatial model

Since A. Downs' "An Economic Theory of Democracy(1957)", the Dawnsian spatial model has become one of the important tools to analyze voting. This model assumed the political agents act to maximize their utility like consumers in the market. By this assumption, the ideological distance between two political agents, i.e. voters and political elites, has a critical role in political choices. Therefore these political elites, such as parties and candidates, try to reduce this distance.

ⅰ) From Economic spatial model to Political spatial model

The Dawnsain model is based on Hotelling's study : "Stability in Competition(1929)". Hotelling tried to find the answer how to produce a stable equilibrium in duopoly with just prices and amount of consumption. In duopoly situation, if one company competing another one lowers slightly, the company can get high benefit, and it will cause cutting price of another. In this case, a stable equilibrium can not be produced. Furthermore, in practice, the slight declining price can not attract many consumers from competitor. Consumers tend to buy product of another one in spite of slightly high price.

Some reasons can be suggested why consumers do not change the company despite a slight increase of price or a slight cutting price of competitor. Hotelling regarded the transportation cost caused by the distance between company and consumers as the main reason. For explanation, he based on some assumptions : First, consumers are evenly distributed in lineal market space ; Second, consumption is inelastic.

For example, company A, consumer x, and company B, consumer y are located left and right in market space respectively. If the transportation cost is equal by a unit of distance, although company A sells its products with more expensive price than company B's price, company A can attract consumers including x who are near it and,

in the case of company B, vice versa. Therefore a price can increase until offsetting by the benefit from proximity, and the price will become the equilibrium in the market space.

This principle can apply to location of company, and the quality of products. If company A plans to move its location in the market space, by closing to company B, company A tries to take consumers from company B. In this case, the best solution to maximize company's profits puts its location on the closest place to competitor. If two company move in the space, their locations, finally, will be the middle of the marker space. Also, it can cause qualitative agglomeration of products. If two companies sell juice and consumers with the preference about the various degree of sourness of juice are evenly distributed in liner market space, the degree of sourness of juice will be quite similar like location of company.

Hotelling's model can apply to politics. If consumer, company, and transportation cost change voter, party or candidate, and ideology respectively, this economic situation becomes political. In practice, we can see that parties do not clearly express own platform. By his model, a party tries to show the similar position to competitor to get more votes, and candidates tend to pussyfoot about questions to ask clear position about issues. By doing this, party and candidate try to maximize the vote, and avoid the loss by showing radical position.

Hotelling's model was upgraded well to apply empirical analysis by A. Smithies. Smithies changed Downs' the second assumption to consumption is elastic, in other words, the consumption is affected by the price. Hotelling's model was monopolistic situation. Therefore the consumers had no choice but choosing one company or another, and should pay excessive cost caused by monopoly. Consumers now do not buy products if the price or the transportation cost is too high. This propensity impedes agglomeration of two companies, because if they are agglomerated, they have to give up consumers who are located in the end of left or right side. Finally, the equilibriums of the two companies will be little separated places, not agglomeration. Politically, voting also is elastic, therefore if party's ideology quietly parts from voters' one, they will abstain from voting. It causes to prevent a convergence among parties.

ii) Dawnsian Model

In Downsian model, the elemental premise is that voters rationally and deliberately act for political and economic purposes. Also the preference of agents can be expressed by a utility function and the character of utility is ordinal as well as cardinal. Therefore, the utility function can show both the order and the intensity of preferences

Downs accepted Smithies' assumption and removed the first assumption of Hotelling, so voters are variously distributed in the space.

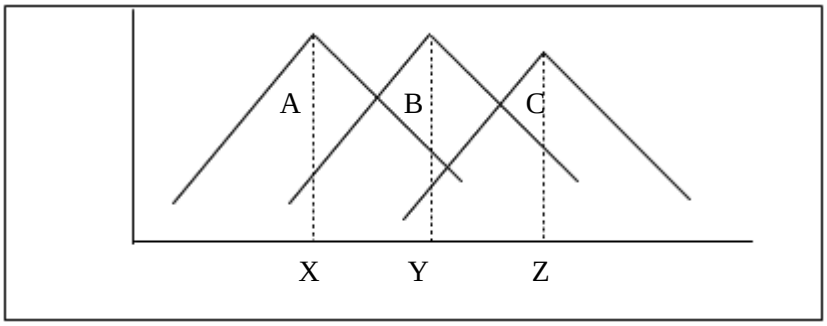
Every voter has single-peaked preference, and the critical issue, ideology, can represent every political issue. Consequently, the Dawnsian model has one-dimensional space. In this model, parties and candidates have agglomerative tendency like models of Hotelling and Smithies. However, unlike other models, the agglomeration can only emerge when the distribution of voters is even or normal distribution. If the distribution is bimodal, parties will tend to be separated in stead of agglomeration. If voters are by normal distribution in one-dimensional space, although parties and candidates are under divergence pressure mentioned by Smithies, they will be agglomerated. Because more voters are near the middle of the space than the end of sides, they can get more benefit than loss of radical voters.

Under certainty, however, radical voters' abstention is irrational. Although two parties are slightly different, the voters can get even minuscule benefit by this difference. Therefore voting the party which is the closest to radical voters is rational. On the other hand, under uncertainty, this abstention can be rational, because the cost will be needed to find the little difference of parties. In limited information, it is difficult to know this difference, and this causes to make their abstention be more rational.

Under this uncertainty, if the voters' distribution is bimodal, it can lead to confusion of bipartisan democracy, because this situation aggravates internal conflicts, regardless which party wins. Downs insisted that after this confusion, people's consensus to tackle it makes the distribution of voters become normal distribution. Consequently, bipartisan democracy recovers its stability.

2. The Proximity model

In traditional spatial model, the utility is determined by proximity. Committee voting is a good example to explain proximity model. If there are three voters A, B, and C with single-picked preference about alternatives X, Y, and Z in the committee, their utility can be depicted Figure.1



<Figure.1>

X is an ideal point or a bliss point of voter A, which can get the best benefit on alternative X. The more an alternative part from X, the less benefit voter A will get. In this case, Y will be chosen as the alternative of committee voting, because A will choose Y to avoid the worst choice Z for A, and C also make the same choice to prevent the worst choice X for C. Consequently, in this committee, the ideal point of the median voter(voter B) will be a equilibrium. This principle also can apply to mass election.

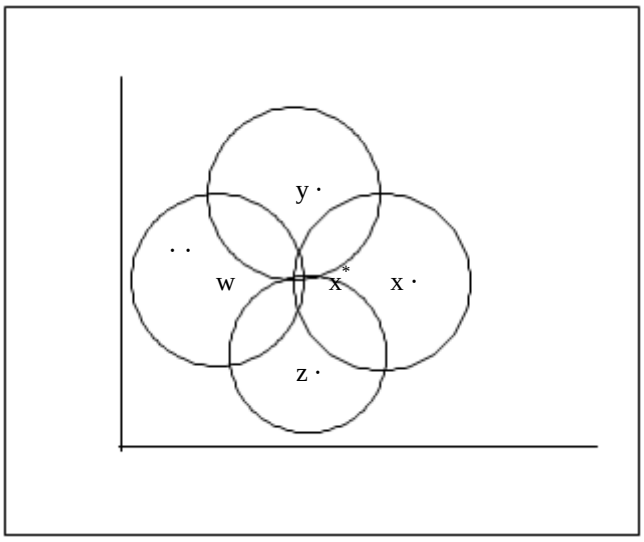
To mathematically generalize, it can be thought that if alternative Y, Z are suggested, A will choose the closest alternative to own ideal point X for maximizing utility :

$$| Y - X | < | Z - X |$$

This structure of utility can be more generalized in two dimensions. In this space, the distance between point $y = (y_1 , y_2)$ and point $z = (z_1 , z_2)$ is given as

$$|| y - z || = [(y_1 - z_1)^2 + (y_2 - z_2)^2]^{1/2}$$

According to this equation, a voter will show the same extent preference to alternatives which part from own ideal point by the same distance. Therefore, many indifference curves with the ideal point as its origin can be drawn. In Figure.2, there symmetrically are 5 deal points of 5 voters respectively, and one in many indifference curves of representing voter's utility was depicted.



<Figure. 2>

In this case, 5 voters would insist their own ideal point at first, but if they persist in their own position, the result could be the worst choice in simple majority. Therefore, the voters will compare the distance between others' ideal points and own ideal point to prevent the worst choice, and they will choose x*, i.e. the median voter's ideal point. (D. Black ; C. R. Plott).

The proximity can be calculated by three ways :

① $\| y - z \| = \sum_{i=1} [(y_i - z_i)^2]^{1/2}$

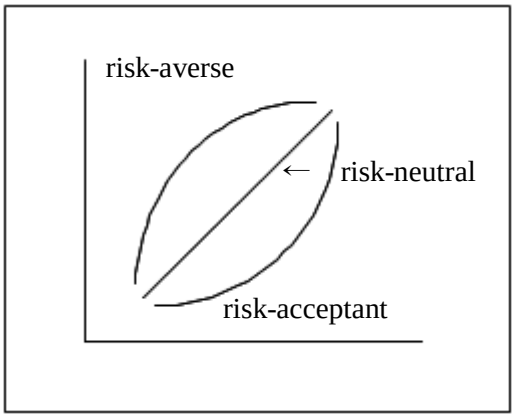
② $\| y - z \|^2 = \sum_{i=1} (y_i - z_i)^2$

③ $\| y - z \| = \sum_{i=1} | y_i - z_i |$

Also, the less proximity of between the voter and alternative is, the more utility the voter can get. Therefore, the utility is in inverse proportion to the proximity :

∴ Proximity utility function : U(y , z) = - (proximity equation)

In spatial model, the voter can be characterized by having a risk-averse tendency. In economic theory, there are three types of agents : risk-averse, risk-acceptant, and risk-neutral. Figure. 3 represents their utility function



<Figure.3>

Among proximity utility equations, the second one is the most similar to the utility function of the risk-averse agent. In this thesis, therefore, the second equation will be used, and this function is defined by

$$U(y, z) = -\sum (y_i - z_i)^2 = -\| y - z \|^2$$

Ⅲ. Directional Models

The directional models criticize limitation of the proximity model. The proximity model suggests convergence of candidates or parties, but in practice, it exceptionally emerges. According to the directional model, the reason is the proximity has unrealistic assumptions. There are two basic spatial models based on directionally that can be seen as alternatives to the proximity model : Mattews Model, Rabinowitz -Macdonald Model.

1. Matthews Model

S. A. Matthews criticized strict four assumptions of the proximity model, and tried to soften these assumptions.

These assumptions Matthews mentioned are :
First, in the proximity model, Euclidean model is also called, candidates' message can be placed as a point in Euclidean issue space, and the point also represents the promise (issue outcome) which the candidate will fulfill when he or she will be elected. However, since candidates have a perfect mobility and there is perfect communication between candidates and voters under this assumption, this becomes too powerful assumption.
Second, every promise is trusted. Consequently, it is the same between the point which the candidate promised before being elected and the point which the candidate will fulfill after election.
Third, every preference has completeness, and has declining function of distance from voter's ideal point to alternatives.
Fourth, candidates know every voter's preference in the space.

Matthews changed these assumptions to the followings :
First, candidate's the message and the issue outcome can be placed as a point in the Euclidean space, but voters will perceive this message and issue outcome as the point which has marginal distance from status quo, because voters do not believe radical promises and expect the candidate not to make enormous changes from status quo

whatever he or she promises. Therefore, importance of the distance is lessened, and only direction can be meaningful.

Second, because of imperfect communication, high information cost will be needed for voters to know an exact location of candidate's issue alternative. Although voters can not perceive a candidate's location in the Euclidian space, if the candidate expresses the pros and cons about an issue, it will be meaningful message to voters about changing direction from status quo

Third, the preference ordering can be well-defined and have completeness only near status quo. Hence, an individual preference will be a radial pattern, centering status quo. Candidates also perceive that only message near status quo make voters believe it. In this case, candidates do not need to develop more strategy but suggesting direction.

Fourth, if the relation among voters and candidates' message or issue outcome can be geometrically exhibited, the space will be non-Euclidian space, like a hypersphere.

In Matthews model, voters prefer the platform of parties or candidates which has the lowest angle between the platform's direction and voters' own direction about the issue.

To measure utility of Matthews model, it can be assumed three direction vector C_1, C_2, and V. V is the direction which a voter prefer the most, and c represents the direction of candidate about a issue. The extent of voter's preference can be expressed by inner product of vectors : $C \cdot V$.
Therefore, in the case of $C_1 \cdot V > C_2 \cdot V$, the voter will prefer C_1. Also, this utility structure can be related with the proximity model. If vector Z_1, Z_2 with direction and distance have the same direction as vector C_1, C_2, respectively and have the same distance (D), it can be possible that $C_1 = Z_1 / D$, $C_2 = Z_2 / D$.
According to this, C_i can be thought as a unit vector with the same direction as Z_i and having 1 distance. Vector V and C can be normalized by dividing by each distance. Through this, more generalized utility function can be made by :

$U(V, C) = V \cdot C \Rightarrow V \cdot C / \|V\| \cdot \|C\| = \cos\theta$ (← using the cosine rule)

According to $-1 \leqq \cos\theta \leqq 1$, the utility function has 1 of maximum value when the directions of a voter and a candidate is the same, and has -1 of minimum value when their directions are opposite each other.

2. Rabinowitz·Macdonald Model

Rabinowitz and Macdonald characterized the proximity model as followings :
First, each voter can be placed as a point in the hypothetical space, and the point

represents an individual ideal point about an issue. Second, the issue position of each candidate can be exhibited in the same space of voters. Third, voters will choose the closest the candidate to them.

Based on these characteristics, voters know ordered alternatives about an issue in the proximity model. According to empirical studies, however, meaningful preferences about an issue often are not well-defined, rather than dispositional or diffuse. Also, in practice, candidates often tend to diverge in the space, not converge. Rabinowitz and Macdonald insisted the reason of incompatibility was caused by failing to distinguish different features of each issue. According to them, there are two types of issues : classic position issues and dispositional issues. For example, the busing issue in the USA (using school buses for students to promote harmony between races) caused various opinions – e.g. where it will fulfill, whether it will be compulsory, and the extent to which people agree or disagree, etc. This issue can be regarded as a classic position issue, because voters and candidates can be placed in the issue dimension. However, voters and candidates can be categorized by three types : agreement, disagreement, and neutral. If a voter agree to introduce the busing issue, he or she will support a candidate who has the same opinion as him or her. In this case, a radical opinion of a candidate will be more attractive to voters who have the same opinion, because it represents intensity of the issue. Therefore this kind of issue can be called dispositional issues.

Since it can be assumed that every voter has dispositional tendency, the spatial model has to accept this factor. Hence, Rabinowitz and Macdonald presented their model (RM model) which has characteristics, which issues have diffuse feature, and is related with symbolic politics.

The symbolic politics is one of the distinct features of RM model. Therefore issues are connected with the agent's feelings or emotion. To express responses caused by feeling or emotion in formal way, two features of symbol can be thought. One is the direction of responses. The agents can be agreeable or disagreeable about an issue. The other is magnitude or intensity of response. Accordingly, the direction and intensity are reflected in the spatial model.

In the RM model, these feature mentioned can be formulated by

(voter's position – neutral point(=status quo)) · (candidate's position – neutral point)

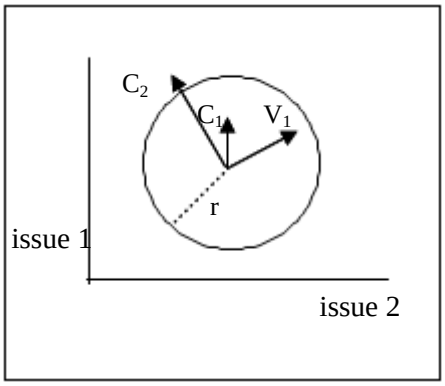
If a voter and a candidate are in the same direction, this product will be positive, and vice versa. Also, this formula can express the intensity. The far a candidate's position with the same direction as a voter's position parts from status quo, the more intensive and positive response the candidate can get.

We can extend RM model to apply multi issues, and the utility function can be generalized by :

$U(V, C) =$ (voter's position$_i$ – neutral point$_i$) · (candidate's position$_i$ – neutral point$_i$) = V C

In this function, i represents various issues, and the value of this function will be scalar product – i.e. the product of two vectors

Although RM model can give persuadable explanations to empirical studies which the proximity model can not explain, the RM model also has a serious defect. According to this model, every candidate tries to be radical, because they can get more votes by doing this. It is an unrealistic result. To tackle this problem, they suggested the region of acceptability.



<Figure. 4>

In Figure. 4, the circle represents region of acceptability, the candidate's position(C_1) about the issues in the circle can be thought to be trustable. While the position will be out of the circle, the candidate(C_2) will lose voter's support. However, this does not mean a defeat of C_2, voters just will penalize the candidate who crossed the circle. Therefore, C_2 gets less support than C_2 expected. Therefore, candidates try not to express more intensity about issues than radius r (a region of acceptability). In spite of a region of acceptability, an empty center which is caused by diverging candidates can not be impeded, because candidates try to put their positions on near a region of acceptability to maximize support.

3. Comparison of Spatial models

The utility functions I have mentioned are followed by:

$U(V , C)pr = - \sum (V_i - C_i)^2 = - \| V - C \|^2$

$U(V , C)_M = V \cdot C / ||V|| \cdot ||C|| = \cos \theta$

$U(V , C)_{RM} = V \cdot C$

To compare each function, the two dimensional space can be assumed with horizontal axis(issue 1) and vertical axis(issue2).

If agents' positions are V(4,1), C_1(1,-1), and C_2(4,-1), then $U(V , C_1)pr = -13$, $U(V , C_1)_M = 0.51$, $U(V , C_1)_{RM} = 3$, and $U(V , C_2)pr = -4$, $U(V , C_2)_M = 0.88$, and $U(V , C_2)_{RM} = 15$. In this case, C_2 has more strong opinion about issue 1 than C_1. This difference strongly influenced the distance and scalar product, while Matthews model was relatively little influenced, because the angle is not big different. Therefore it can be thought that Matthews model is not sensitive to agents' intensity about issues.

In another situation, if V_1(1,1), V_2(4,1), C_1(1,-1), and C_2(1,-4) ($\because$ the angle is 90^o between V_i and C_i), then $U(V_1 , C_1)pr = -4$, $U(V_1 , C_1)_M = 0$, $U(V_1 , C_1)_{RM} = 0$, and $U(V_2 , C_2)pr = -34$, $U(V_2 , C_2)_M = 0$, and $U(V_2 , C_2)_{RM} = 0$. In this case, although V_1 and C_1 changed their preference by moving to V_2 and C_2, respectively, RM model and Matthews Model can not recognize it. Therefore, we can know that these models are not sensitive to the differences of agents if they keep the same angle.

Through these situations, the proximity model is highly sensitive to every change. RM model is also sensitive, but if the angle between agents is 90^o, the utility becomes 0, regardless their intensity. Unlike these models, Matthews model is very insensitive.

As we can see, each spatial model has distinctive advantages to explain real political situation, while they also have inherent limitation. If these models properly mixed, it can be expected that they will become complementary.

Ⅵ. Mixed models

Every pure spatial model tried to control uncertainty in real politics. This makes the own characteristics of each model, and imposes limitation. Mixed models seek to tackle this problem

1. Iversen's Mixed Model

Based on the RM model, T. Iversen developed mixed model, because voters tend to prefer clearer opinion about issues to the same opinion as them. Therefore, it is more reasonable that the disparity between voter and candidates influences the utility. Also, through explanations of models, it can be suggested that the proximity model deals with a policy representation, and the directional models deal with an issue leadership. Both of them can not be overlooked for empirical studies. Hence, Iversen suggested a representational policy leadership model.

For this model, Iversen tried to consider symbolic politics with rational perception of proximity model and found possibility for this in limitation of RM model. In RM model, a region of acceptability is a mechanism to restrict unrealistically high intensity to get the most support, but this is post hoc and ad hoc. It is difficult not only to agree this region for every agent, but also to accept this role to independently play. This concept also presents some paradoxes : First, even though a voter finds the most suitable candidate, the voter has to impose a penalty if the candidate cross the region. Second, if only one region of acceptability exists, it can be decided by the most radical voter. Accordingly, the surface of this region will be positions for the most radical voter and candidate. In this case, this region will not have meaning and credibility anymore.

To tackle this problem, Iversen re-conceptualized this region – i.e. every voter has own private region of acceptability with penalty function. Therefore a voter will penalize only candidates who are out of the voter's region. This logic is very similar to the proximity model, which candidates do not want to diverge from voters under this region of acceptability, and the utility can be reciprocal proportion to the distance.

According to this adjustment, Iversen's mixed model (Representational policy leadership model is called) is followed by :

$U(V , C)iver = \quad s\cdot \ V \cdot C - (1-s) \| V - C \|^2, \quad 0 < s < 1$

"s" is sensitiveness to a direction, whereas "(1-s)" means sensitiveness to a proximity.

In this model, the influence of direction outweighs that of proximity in relatively short distance, while the direction is overshadowed by proximity over threshold distance which is different to depend on each agent.

2. MerrillⅢ & Grofman Mixed Model

S. MerrillⅢ and B. Grofman tried to combine all models which have been mentioned with two parameters. One parameter is for relation between Matthews model and RM model, through this, this model can measure the influence of intensity. The other parameter is regarding the relation between proximity model and directional models.

In terms of the first parameter, RM model is the product of two vectors of a voter and a candidate, and this model can be analyzed by two factors : a factor for direction and a factor for intensity.

$U(V , C)_{RM} = V \cdot C = (V \cdot C / ||V|| \cdot ||C||) \cdot (||V|| \cdot ||C||)$

In this function, $(V \cdot C / ||V|| \cdot ||C||)$ is Matthews model, representing a direction. As a distance means intensity in the space, the product of distances – i.e. $(||V|| \cdot ||C||)$ – can represent intensity.

Merrill and Grofman use a parameter "q" to control influences on issues from direction and intensity, respectively.

$(V \cdot C / ||V|| \cdot ||C||) \cdot (||V|| \cdot ||C||)^q$

If q = 0, then the intensity factor can not influence the utility function, becoming Matthews model. On the other hand, if q = 1, then this function becomes RM model.

Moving on to the second parameter, they tried to mix RM model and proximity model like Iversen. By using the Iversen's model with a parameter "ß" in stead of "s", they made a mixed model, and called RM model with proximity constraint, or mixed proximity model.

$U(V , C) = 2(1-ß)V \cdot C - ß || V - C ||^2$

Accordingly, ß means strength of constraint to RM model. Therefore, if ß = 0, then RM model can play a full role in the space without constraint. While if ß = 1, then this function becomes pure proximity model. By multiplying the value 2(1-ß), they accounted for the agent behavior more extreme than that of proximity but less than that of the RM model.

Furthermore, Merrill and Grofman combined these formulas each other, and through these parameter used in the new model, we can know which model gives more appropriate explanation to empirical studies.

M&G mixed model is followed by :

$U(V , C)_{M\&G} = 2(1-ß) \cdot (V \cdot C) \cdot (||V|| \cdot ||C||)^{q-1} - ß || V - C ||^2$

This model can be meaningfully thought by using one model to measure relation voters and candidates in real political situations.

M&G model can be summarized by following table.

	ß	Q	U(V , C)
Proximity model	1	·	$- \| V - C \|^2$
Matthews model	0	0	$2(V \cdot C) / (\|V\| \cdot \|C\|) = 2\cos\theta$
RM model	0	1	$2V \cdot C$
M&G mixed model	$0 \le \beta \le 1$	$0 \le q \le 1$	$2(1-ß) \cdot (V \cdot C) \cdot (\|V\| \cdot \|C\|)^{q-1} - ß \| V - C \|^2$

Ⅴ. Applicability to Korean Society

As we have seen, the spatial models have developed from Downsian model to mixed models. I am trying to apply the spatial models to Korean society, but it will be experimental, because there are some difficulties in applying these models. First of all, the surveys were not designed for this kind of models. Secondly, the issue voting is not familiar to voters and candidates yet, because of long authoritarian experiences. Consequently, the researches about the issue voting are not sufficient.
In spite of these difficulties, applying the spatial model will help us to understand a mechanism about relations between Korean voters and candidates. Moreover it can contribute to increasingly important issue voting research since the democratization of Korea. In addition, SPSS will be used as a statistical tool in this thesis.

1. Issues

Every spatial model is based on the issue voting. Issues can play a role as information provider about candidates or parties. For application of the spatial model, I will use ideology and the sectionalism(regional issue) which has seriously been considered as issues. In particular, the sectionalism has been regarded as the most influencing factor in Korean elections. This concept can be defined by hostile feelings against “Honam “, which is Kim Dae-Jung’s hometown.

2. Data

Unlike election studies in USA or European counties, we do not have sufficient researches and data about issue voting. Therefore it is difficult to carry out a research, comparing elections to produce more appropriate results. So I will use the survey data about the Presidential election in 1997 by Korean Social Science Data Center (KSDC), not various surveys.

The survey data were collected by quota sampling and from 1207 interviewees through the whole country except "Jeju" province.

Because of some difficulties inherent to data I mentioned, we need three changes about data. First of all, we need thermometer score about candidates to measure utility. However, there was not overall evaluation for this in data. Therefore a composite score will be used as an alternative. According to S. MerrillⅢ's reply to my e-mail, " a composite score is probably the best I can do".
To make a composite score, I used 7 questions about satisfaction in candidates.
First, "Are you satisfied with the candidate who you voted ?" If respondents positively answered, then the candidate will get 1 point.
Second, "Which candidate do you like ?" If respondents said the candidate's name, then the candidate will get 1 point.
Third, "Which candidate do you dislike ?" If respondents said the candidate's name, then the candidate will lose 1 point.
Fourth, "Which one do you prefer the Ruling party or Opposition parties ?" If respondents answered the Ruling party, then the candidate of this party will get 1 point, and vice versa.
Fifth, "Which party do you like?" If respondents said the party's name, then the candidate of this party will get 1 point.
Sixth, "Which party do you dislike?" If respondents said the party's name, then the candidate of this party will lose 1 point.
Finally, "Who do you think can tackle current problems of Korean society?" If respondents said the candidate's name, then the candidate will get 1 point.
By doing this, we can get a composite score from -2 to 5. To avoid minus utility, 2 can be added. Consequently, a composite score's range will be $0 \leqq$ composite score $\leqq 7$

To know the relation between a composite score and choices of voters, I used regression analysis. The dependant variables are choices in the election, and the independent variables are the composite score of candidates.

Candidate	Regression coefficient	R	Mean score in voting the candidate / Mean score in not voting the candidate
Lee, Hoi-Chang	1.88**	0.38	5.24 / 1.04
Kim, Dae-Jung	1.42**	0.46	6.09 / 2.15
Lee, In-Je	2.03**	0.45	4.96 / 2.33

* : $p < 0.05$, ** : $p < 0.01$

According to this table, we can find high correlation between choices of voters and a composite score. As a result, a composite score can be used as utility in this analysis.
In terms of the second change about data, data about ideology are rearranged that

conservative responses are placed the right side(having plus values) of 0, neutral responses get 0, and liberal responses are placed the left side(having minus values) of 0.

Finally, it is a change for the regional issue. There are two questions about this issue in the data. One is whether respondents will run business with people who come from "Honam", and the other is what do you think about a spouse whose hometown is "Honam". For application, if interviewees positively answered to each question, 1 point is given, and vice versa. Therefore this issue's range will be -2 ≦ regional issue ≦ 2. If the value is positive, the respondent is favor to "Honam", while if the value is negative, the respondent will be hostile to "Honam". Through this, we can know voters' positions about the regional issue, however we can not know the candidates' positions. To solve this problem, the regional issue will be regarded as fully dispositional issue. As it is mentioned, a dispositional issue can be expressed only three ways : agreement, disagreement, and neutral. Hence, the positive values of regional issue will be 1 and the negative values will be -1. Also, we can, at least, know Kim Dae-Jung's position, having 1 point about the regional issue. However we can not still know other candidates' position.

3. Application

First of all, data about ideology issue are analyzed by using pure spatial models.

Candidate	Spatial model	Correlation coefficient
Lee, Hoi-Chang	Proximity	0.241**
	RM	0.236**
	Matthews	0.257**
Kim, Dae-Jung	Proximity	0.146**
	RM	0.174**
	Matthews	0.176**
Lee, In-Je	Proximity	0.110**
	RM	0.128**
	Matthews	0.132**

* : $p < 0.05$ ** : $p < 0.01$

According to this table, although influence of ideology was small, comparison among models is possible. Correlation coefficients of Matthews model are greater than those of other models. In case of Lee, Hoi-Chang, correlation coefficients of all model are greater than others.

A regression analysis shows following table :

Candidate	Model	Regression coefficient	Standardized regression coefficient	R^2
Lee, Hoi-Chang	Proximity	0.156**	0.241	0.058
	RM	0.396**	0.236	0.056
	Matthews	0.782**	0.257	0.066
Kim, Dae-Jung	Proximity	0.106**	0.146	0.021
	RM	0.298**	0.174	0.03
	Matthews	0.553**	0.176	0.031
Lee, In-Je	Proximity	0.045**	0.110	0.012
	RM	0.126**	0.128	0.016
	Matthews	0.247**	0.132	0.017

* : p <0.05 ** : p <0.01

This table shows that all model regarding Lee, Hoi-Chang can provide better explanation, and Matthews model regarding all candidates is fitter than other models.

Moving on to the regional issue, Kim, Dae-Jung will be focused, and only Matthews model will be used, because of the limitation of data. The result of the statistical analysis is followed by :

	Correlation coefficient	Regression coefficient	Standardized regression coefficient	R^2
Kim Dae-Jung	0.447**	0.803	0.491	0.241

* : p <0.05 ** : p <0.01

As the table shows, all coefficients increase compared with those of ideology. Through this result, we can know that the regional issue is more powerful factor than ideology in the Presidential election, and regarding the regional issue, Matthews model is very fitted model.

Now, relation between Kim, Dae-Jung and voters in two-dimensional space (Ideology and the regional issue) will be analyzed.

	Model	Correlation coefficient	Regression coefficient	Standardized regression coefficient	R^2
Kim Dae-Jung	Proximity	0.1**	0.057**	0.10	0.01
	RM	0.382**	0.543**	0.382	0.146
	Matthews	0.434**	1.44**	0.434	0.188

* : p <0.05 ** : p <0.01

By adding the dispositional issue, the RM model's coefficients increased compared with previous analysis, but the proximity model's coefficients decreased, and Matthews model's coefficients also declined compared with the analysis which used only the regional issue. Therefore, we can say symbolic politics is more influencing factor than rational factor regarding analysis about Kim Dae-Jung.

Finally, the result from using M&G mixed model is followed by :

	ß	Q	R^2
Lee Hoi-Chang	-0.57	0.29	-0.54
Kim Dae-Jung	-0.87	0.32	-0.96
Kim Dae-Jung (in two dimension)	-0.5	0.2	-0.7
Lee In-Je	-0.65	0.06	-1.56

According to this table, M&G model is unfitted to apply to empirical study. First of all, R^2 values are negative, and ß values also crossed the range, $0 \leq \beta \leq 1$. Therefore, under this situation, it is little meaningful to use M&G model to analyze the Presidential election in 1997.

As we have seen, the fittest model to explain Korean election can be thought directional model, in particular, Matthews model. The reason, in my view, is that Korean voters could not have sufficient information to rationally compare every candidate about issues. In other word, it can be said that Korean voters are under the uncertainty in choosing candidates. Also in the case of Lee Hoi-Chang of the Ruling party's candidate, coefficients of the proximity model are relatively greater than others. It means voters have more information about candidate of the Ruling party

than those of the opposite parties, because voters know what the ruling party has done for ruling period, so they could easily infer what the candidate will do and the candidate's position about issues.

4. Suggestions for data

As I mentioned, the survey should be adjusted to do successful empirical research which use spatial models. Therefore I will suggest some solutions to overcome this problem.

First of all, for spatial model analysis, we need information about voters as well as candidates regarding issues. Therefore, both voters' opinion on issues and voter's opinion on candidates' position about the issues are indispensible to analyze. Consequently, the questions about candidates' position in surveys should be asked.

Secondly, the regional issue has a big meaning in Korean election, and it is emotional factor. However, this survey heavily focused on feeling side. In spite of this characteristic of the regional issue, if the questions also involved in policies, this issue could provide more information, and it could help to carry out more various researches about the influence of sectionalism.

Finally, thermometer scores are essential in analysis with utility functions, because voters' thermometer scores can be interpreted by utilities. Therefore, voters' evaluation abut candidates should be inquired, for example, scores have range from 0 to 100.

Ⅵ. Conclusion

Every model which I have mentioned in this thesis tried to control uncertainty, and the way of controlling uncertainty made models' own features and inherent defects.

The proximity model can provide powerful explanations and predictions, but this model also has unrealistic assumptions. Unlike its assumptions, the agents are not under certainty which of degree this model assumed.

The directional models started on criticism about these assumptions. These models suggested voters perceived candidates with uncertainty, and they are influenced by symbolic politics because of information cost. Therefore, the directions become more important than the proximity.

However, the directional models also have defects, and these defects can be complemented by the proximity model. Mixed models seek to make more appropriate spatial model by combining pure models.

The application to Korean election suggested that voters are under uncertainty. Therefore, Matthews model which is focusing on only direction can become the most fitted model. However it is too difficult to apply M&G model to Korean election, because of the limitation of data.

For more suitable analysis, we need some adjustments in surveys. In particular, it is necessary that more information about candidates should be asked, and more questions about issues should be inquired.

Even though the empirical research in this thesis has limitations, it can be expected that this experimental research will contribute to make foundation for issue voting studies by using spatial models.

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