Frame Dependent Modeling Of Influence Processes

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Frame dependent modeling of influence processes

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Introduction

In the second half of the last century we have observed a shift in focus from power studies to outcome oriented studies. In the original power studies, power indicators were not derived from a model of the influence process, but defined in a broader theoretical context. Examples are the classical local power studies of Hunter (1953) and Dahl (1961), where different measurement procedures resulted in fundamentally different conclusions and incomparable results. Whereas Hunter defined power as a potential and measured it by reputation ratings among leading persons, Dahl defined power as effective participation in actual decision making and measured it by studying actual decision making processes. As a reaction, others stressed the importance of non-decision making (among others, Bachrach and Baratz 1963). In a comparable way, early network approaches focused on the definition of status scores of which those of Katz (1953) and Hubbell (1965) are the most well-known. Also early network studies were unable to connect network positions with effects and derived influence and power from positions in networks. The Ten Country Study on Networks of Corporate Power in which Rolf Ziegler and I both participated is an excellent example of that approach (Stokman, Ziegler and Scott 1985).

The shift of focus to outcomes is particularly due to Coleman's exchange model (1972; 1990). Coleman assumed that actors have interest in some events and control others. By exchanging control over events in which they are less interested for control over events in which they are more interested, mutually beneficial outcomes can be achieved. The major mechanism in this model is that of a market. The model is able to predict the division of control over the actors in equilibrium. It is important to notice that power of actors and value of events can now be derived from the model and are not anymore ad hoc

introduced. Whereas the original Coleman model assumed unrestricted exchange possibilities, later models introduced unequal exchange opportunities by connecting Coleman's exchange model to networks (Marsden and Laumann 1977; Laumann and Knoke 1985; König 1997; Pappi and Henning 1998). In these models, structural constraints force actors to exchange with particular others. Moreover, the models were adapted to predict outcomes on dichotomous yes/no decisions. Coleman's model became thus extended to outcomes of collective decision making processes. Also Network Exchange Models (Cook and Yamagishi 1992; Willer 1999 and many others) study network effects on exchanges. Whereas Coleman's model is based on global equilibria, Network Exchange Models focus on network effects upon exchange rates between pairs of actors. Splitting common pools represents exchanges and power arises primarily because of the possibility to exclude others from exchange and is defined in terms of shifts of exchange rates in one's own advantage.

Network influence models also show a shift to outcomes. Weighted influence networks were not anymore connected to status scores, but to social influence on individual opinions and attitudes. These contagion models (Friedkin and Johnsen 1990; 1997; 1999; Marsden and Friedkin 1993 and Leenders 1995; 2002) assume that opinions and attitudes of actors in a social system only partially depend on individual characteristics but are also shaped by social influence. The social influence part is represented in an influence network, reflecting the dyadic influence of actors on each other. Technically, spatial autocorrelation algorithms are used to capture such processes.

Third, Bueno de Mesquita (Bueno de Mesquita et al 1985; Bueno de Mesquita 1994) stresses that the nature of politics is conflict resolution in which power dominates over arguments or exchange. In situations of conflicts of interests between actors, reflected in different positions regarding the desired outcome of political decisions, collective outcomes arrive through a process in which actors challenge each other's positions. In such challenge processes differences in power and salience play an important role. To the degree that the salience for the issue is lower and the power dominance for the other position is larger, the actor will be inclined to give up his[i] own position. It saves unnecessary costs to uphold a position on an issue that is only marginally related to the

own interests. The process is therefore represented by a non-cooperative game.

All three approaches -exchange, contagion, and power- have claimed to be universally valid, or at least, do not specify under which conditions they are valid or not. Within the exchange approach, no communication exists between the Coleman adepts and the Network Exchange Theorists. The Network Exchange Theorists claim that splitting a common pool is a valid representation for exchange, which is only the case under certain conditions (Van Assen 2001). The contagion approach seems to be guided more by the statistical elegancy of the spatial autocorrelation model than by a thorough analysis of the underlying contagion process. Finally, exchange and contagion models predict in their original formulations primarily outcomes at the individual level. When applied to predictions at the collective level, adaptations often have a strong ad hoc level. In my own approach I have tried to find theoretically sound solutions for that step. Stokman and Van den Bos (1992) connect influence networks to collective outcomes by connecting influence networks to issues on which both the positions of actors regarding the desired outcome as the collective outcome itself can be represented. Stokman and Van Oosten (1994) do the same for exchange processes by representing the exchange process as an exchange of voting positions on such issues. This results in an integrated approach in which contagion, exchange and challenge can be represented and studied (Stokman et al. 2000; Stokman and Wittek 2002). The elaborate theoretical and methodological basis of this research allows considerably accurate predictions concerning the outcomes of substantive conflicts.

In this paper, I would like to illustrate the need for a good theoretical basis of the models by providing two procedures to determine influence weights for influence relations. The first concerns influence weights in policy networks, focused on collective outcomes, the second weights in friendship networks, focused on social influence among peers and unrelated to collective outcomes. In this elaboration, I will simultaneously formulate conditions under which contagion processes in collective decision making are to be expected.

Modeling influence in policy networks

Understanding collective decision making requires a clear distinction between ultimate goals and instrumental goals. Instrumental goals can be considered as means through which ultimate goals can be realized. Figure 1 illustrates typical utility functions to be expected for both types. Utility functions for ultimate goals are usually monotonously increasing or decreasing, like those in the lower part of the Figure. The first could represent economic growth, the second environmental pollution. Ultimate goals dominate in political discussions, but controversial decisions usually concern instrumental goals. Instrumental goals typically have an optimum: too much is as bad as too little. If the upper part of Figure 1 related to the size of an ecotax, too little would harm the goal of reduction of environmental pollution, whereas too much would harm that of economic growth. The preferred optimum typically depends on the weighting of the two (and possibly other) ultimate goals. As the weighting will depend on the constraints of an actor, different actors will likely support different optima. Moreover, as ultimate goals of certain actors are more affected by such a measure than of others, actors differ in their interest in the outcome. The outcome an actor *i* aims at is denoted his *initial or policy position* x_i, his interest in the issue is denoted his *salience* for the issue s_i. On the basis of this reasoning we model collective decision making as decision making about controversial issues with single peaked preference functions. Solutions of problems may well require simultaneous decisions on several issues. Different issues should represent rather independent controversial elements of the solution and as a set should cover the full range of possible outcomes.

[HERE FIGURE 1]

The dynamics in the decision making process results from the fact that each actor, with different intensity and potential, tries to realize his position whereas only one outcome can be chosen. Small informal groups can often make decisions on the basis of informal

rules and agreements. Collective decision making has to be institutionalized through the elaboration of rather generally accepted decision-making procedures as soon as common interests become more complex and groups larger. Such formal procedures can be found at all levels of society. They specify, among others, which bodies have the authority to make the final decisions, how these bodies are composed and their members selected, at what moment which actors have to be heard or are otherwise involved in the decision making. In addition, rules specify procedures for appeal against decisions that are harmful or not made according the required procedures.

In a complex situation and if many actors are involved, actors will try to build an as large as possible coalition behind their initial positions or behind a position that is as close as possible to theirs. In that way, actors hope to affect the positions of the final decision makers in order to reach a collective outcome that reflects their interests as much as possible. The dynamics of decision making is therefore primarily based on processes through which other actors are willing or forced to change their positions. The contagion, exchange, and power models can be seen to represent three processes that precede formal decision-making and that affect the final positions of the actors in the decision-making. These processes should be distinguished from processes that govern the final voting. Procedural and coalition models aim to represent primarily that part of the political process.

Exchange and power models typically do not affect initial positions and saliences. The result of an exchange is that actors are willing to support another position on an issue that is of relatively less importance to them in exchange for support of another actor for the issue that is relatively more important to them. In a similar vein, actors can feel compelled to support another position under the pressure of power. These processes are primarily likely if initial positions fundamentally differ because of other weighting of ultimate goals. In such situations, arguments do not help to bring initial positions closer to one another, so coalitions can be built only through processes that affect the final or voting positions of actors. Through contagion, however, actors aim at changing each others initial positions as well as the salience of these positions (Stokman et al 2000). The mechanism by which this is achieved is through mutual persuasion. Common interests, based on functional interdependencies, can be argued to be stronger than diversity of

interests (Lindenberg 1997). Consequently, contagion processes usually take place within groups and in early stages of the conflict, because in such early phases the issues and grievances as well as the underlying motivations are not yet fully crystallized, i.e. not all relevant information is available. An important precondition for this mode to function is the existence of structural interdependencies in the form of trust relationships. Put differently, actors need to be embedded into a network of friendly personal relationships, in which they are not only directly tied to each other, but also linked via multiple indirect ties. This structural situation will facilitate framing processes in which intergroup interdependencies are pushed into the background. Cognitive interdependencies prescribe that the decision makers may realize their own personal gain, but without inflicting harm on each other. The actors have a high concern for their own outcome *and* the outcome of exchange partners inside their group. Conflict strategies are likely to take the form of mutual adjustment and problem solving (Stokman and Wittek 2002).

In contagion models, a major question concerns the weights that can be attached to influence relationships between actors. Leenders (2002) found eleven different solutions in the literature and nicely compares them. Stokman and Van den Bos (1992) used the one introduced by Hoede (1979) were the weights are based on the relative resources of actors in a policy network. Actors in policy networks do not only differ in their initial positions and saliences, but also in their resources they can mobilize in the influence process. Depending on the policy network at stake, actor's resources depend on exclusive (expert) information, financial resources, social positions, whatever contributes to the final solution of the problem. Essential characteristic is that these resources are rather independent of the actor's perceptions and consequently can be assumed to be more or less intersubjectively invariant. If we denote actor i's resources by r_i , and denote the existence of an influence relationship from i to j by a_{ij} the weight of the influence relation from i to j (v_{ij})[ii] can then be defined by:

$$v_{ij} = \frac{r_i a_{ij}}{r_j + \sum_{k=1, k \neq j}^{g} r_k a_{kj}} \qquad (1)$$

In this definition we assume that $a_{ii} = 1$. v_{jj} then gives the buffer of actor j that enables him to maintain his own position relative to others. By definition all incoming influences (including the influence he has on his own position) sum to 1.

The amount of influence of individual i on j at time t is seen as the *potential* influence of i on j. Whether i is *willing* to mobilize his potential influence to affect j's position on an issue, depends on how salient the issue is for j. An actors's salience s_i on an issue is also seen as the fraction of influence he is willing to mobilize (Stokman and Van den Bos 1992). The position of individual j on an issue at time $(t + 1)$, $x_j(t+1)$ is obtained by taking the median of j's own position and that of the actors who influence him where each $x_k(t)$ is weighted by w_{kj}:

$$w_{ij} = \frac{s_i v_{ij}}{\sum_{k=1}^{n} s_k v_{kj}} \qquad (2)$$

Stokman and Van den Bos (1992) and Stokman and Zeggelink (1996) take the weighted mean. The disadvantage of the mean is that groups quickly become homogeneous in their values. We may therefore wonder whether empirical results on norm formation in social influence networks (Friedkin 2001) are not at least partly artificial, to be attributed to the applied method of spatial autocorrelation. We prefer the median in our present models to increase the likelihood that minorities will be able to uphold their values on variable dimensions within a larger group

Modeling influence in friendship networks[iii]

Friendship is difficult to define because its characteristics and development are diffuse and flexible. Notwithstanding ambiguity, people agree on the fact that a friend gives

support, can be trusted, shows respect and real interest, is verbally open, and is a comrade. Friendships are particularly instrumental to obtain self-confirmation and social approval. To the extent that they are successful in this respect, they produce social well-being (Cramer 1998; Lindenberg 1990; Ormel et al 1997). The *shape* of the friendship is characterized by voluntariness, privateness, mutuality, durability, frequency of contact and dynamics (Fehr 1996; Bell 1981; Duck 1977, 1988, 1991; Dykstra 1990; Fischer 1982). Although these features cover the whole range of friendships, typical properties of friendships, like contents and structure, strongly depend on the stage in the life cycle and gender of the persons involved, as well as developmental phase of the friendship (Allan 1998; Hays 1988), to name a few.

All theories imply that people do not randomly choose their friends. The very first basis of choice for a potential friend is attraction. Somebody is generally considered attractive if he is similar to you, satisfies your needs, is competent, and likes you. The most prevalent determinant however is similarity. Individuals prefer friends who share their attitudes, values, and beliefs (among others: Urberg et al 1998; Leenders 1995; Duck 1991; Hallinan and Teixeira 1987; Brehm 1985; Dahlbäck 1982; Werner and Parmelee 1979).[iv] Other attraction forces, however, may promote friendships among dissimilar individuals. Davison and Jones (1976), for example, report a generally observed attraction to higher status individuals. Once two individuals have decided that they want to be in a friendship, they develop similar attitudes and interests, which implies rewards by providing social comparison from both sides over and over again (Newcomb 1956, 1961; Schachter 1959).

The model: Goal directed friendship formation

The main driving force behind friendships and friendship formation lies in the observation that individuals differ in their preferences regarding the desired characteristics of their friends. These differences are twofold. First, a characteristic or dimension considered important by one individual might well be irrelevant for another individual. For example, some individuals attach high importance to the fact that their friends are in a certain age range or have certain political views, whereas other individuals do not care about age or political views of their friends. We call the

importance of a dimension for an individual the *salience* of that dimension for that individual. Second, for a certain dimension, like age, individuals differ in the preferred value their friends should have on that dimension. Some individuals prefer friends of their own age; others prefer friends that are older or younger than they are. We call such a preferred value for their friends the individual's *ideal-friend-value* on the dimension. As this example shows, the ideal-friend-value may be equal to the individual's own value on the dimension but that is not necessarily the case. It is crucial, however, that differences exist among individuals in the meaning of dimensions: thus as we call it, in the saliences attached to them, and in the positioning of self and others on these dimensions. It may even be so that dependent on the individual's ideal-friend-value on a dimension he attaches more or less salience to that dimension (Jones 1982). It is for example found that individuals on the extreme of a dimension attach more importance to that dimension (Hirschberg et al 1978).

In our model, we assume that the relevant dimensions are unidimensional and scaled between 0 and 1. The larger the distance between the actual value of a (potential) friend and the individual's ideal-friend-value on a dimension, the higher the *costs* for that individual to establish or maintain a friendship with that individual; the higher the individual's salience for the dimension, the higher the contribution of the distance to the costs. This corresponds to Jones' (1982) suggestion to model the strength of a similarity-attraction relationship as an inverse function of distance between the implicit ideal point of an individual and the other's value on the relevant dimension.

Let us consider individuals i and j (i,j = 1,...,n) and m dimensions (e=1,...,m). We denote individual i's ideal-friend-value on dimension e by x_{ie} and i's salience by s_{ie} with $0 \leq x_{ie}$, $s_{ie} \leq 1$. The actual value of individual j on dimension e is y_{je}. The contribution of j's characteristics to the overall costs (C_{ij}) for individual i for having a friendship with individual j can now be defined as follows:

$$C_{ij} = \sum_{e=1}^{m} s_{ie} \sqrt{| x_{ie} - y_{je} |} \qquad (3)$$

The square root in equation (1) indicates that deviations around the ideal-friend-value result in a larger increase in costs than deviations far away. For individuals with the same ideal-friend-values, costs in making and maintaining friendships are higher for individuals with stronger preferences (salience) on the dimensions. For individuals with different ideal-friend-values but with the same saliences, costs for making and maintaining friendships depend on the availability of others with desired characteristics. We use this cost function as the basis for our measure for influence.

With respect to attractions to or preferences for friends, three types of attraction forces seem to be generally important, but always apply with specific 'adaptations' in specific contexts (Davison and Jones 1976).

The most important type is that of likeness or similarity: individuals prefer friendships with individuals who are similar to themselves (among others: Lazersfeld and Merton 1954; Duck 1991). In that case, the individual's ideal-friend-value is equal to that individual's own actual value: $x_{ie} = y_{ie}$ in Equation (1). If this applies to all individuals on a dimension, we speak of a *similarity* dimension. Examples of similarity dimensions are variable attributes like opinions, attitudes, and behaviors, and non-variable characteristics like gender.

Individuals do not exclusively aim at similar friends in all circumstances. We can distinguish two different attractive forces for dissimilar friends. The first is known from reference group theory (Festinger 1954; Schachter 1959). If an individual would like to belong to a group to which he does not belong, he will be attracted to (potential) friends with characteristics dominant in that group. The generally observed attraction to higher status individuals (Davison and Jones 1976) is related to this. Status and, more generally, reference group characteristics can be introduced through ideal-friend-values where x_{ie} is equal to, for example, the average value of the *aspired* group and consequently unequal to y_{ie} if i does not belong to that group. If this applies to all individuals on a dimension, we speak of an *aspiration* dimension.

The other attractive force for dissimilar friends stems from the desire to have friends with *complementary* characteristics. Becker (1991) demonstrated the importance of complementarity in social selection for marriage markets. In friendship formation,

complementarity certainly applies in specific settings, such as organizations. Again the ideal-friend-value of the individual is unequal to the individual's actual value, but the individual has no aspiration to reach that value for himself. We speak of *complementary* dimensions if all individuals seek friends with complementary values on such a dimension.

Influencing

The influence process describes how some individual characteristics change as a result of their friendships. In the literature on social influence processes, the emphasis lies on changes of individual characteristics like opinions, attitudes, behaviors that would become more similar. According to Hunter et al. (1984), different theories exist that try to explain how attitude change comes about. Literature on influence networks typically does not question the targets of influence and usually confine the influence process to (a subset of) opinions, attitudes and behavior (Festinger 1954; French 1956; Friedkin 1986; Marsden and Friedkin 1993 Friedkin and Johnsen 1990; 1997; 1999; Friedkin 1999). *From our model, we can derive three possible targets for social influence: the ideal-friend-values, the saliences, and the actual values of the individuals on the dimensions.* The latter are confined to those dimensions that are subject to social influence (like behavior, opinions, or attitudes opposed to characteristics like gender or age). The influence process can result in changes in any of the three values or in any combination of them. We assume that the strength with which individual *i* influences *j* depends on *j*'s evaluation of *i*'s characteristics. The more *i*'s characteristics match with *j*'s ideal-friend-values on highly salient dimensions, the higher the evaluation of the friendship by *j* and the more weight *i* will have on *j*'s saliences, ideal-friend-values, and actual values. This is a generalization of the social comparison theory of Festinger (1954), stating that influence between actors declines as a function of the discrepancy of their opinions and behavior. This implies that influence processes in friendship networks are not based on objective resources like money, social position, or expertise, but on pair wise evaluations of the other's characteristics. Resources of an individual as such differ for every pair of individuals, and are by definition not symmetric (direction dependent). We define r_{ij} as

the value of *i*'s resources from *j*'s viewpoint over all dimensions *e*. The smaller the differences between *i*'s actual values and *j*'s preferred values on the dimensions, the larger the resources of *i* with regard to *j*.

$$r_{ij} = \frac{1}{m} \sum_{e=1}^{m} s_{je} \left(1 - \sqrt{|x_{je} - y_{ie}|}\right) \qquad (4)$$

The definition includes the resources of an individual with regard to himself, r_{jj} . The more the individual's ideal-friend-values match with his own actual ones for highly salient dimensions, the higher the resources of *j* with respect to himself. The higher the resources with respect to himself, the more difficult it is for others to influence *j*.
The influence of a friend does not only depend on the friend's resources, but also on the resources of the individual's other friends and the individual's own resources over himself. The amount of control $v_{ij}(t)$ of *i* over *j* is defined as follows[v] (see also Stokman and Van den Bos 1992):

$$v_{ij}(t) = \frac{r_{ij}(t)\, a_{ij}(t)}{\sum_{k=1}^{n} r_{kj}(t)\, a_{kj}(t)} \qquad (5)$$

where

$a_{ij}(t) = 0$ if *i* and *j* are not friends at time *t*

$a_{ij}(t) = 1$ if *i* and *j* are friends at time *t*.

Since we assume a friendship to exist as soon as choice is mutual, $a_{ij}(t) = a_{ji}(t)$.
For each individual, by definition, all incoming control (including the control over himself) sums to unity.
When saliences are subject to social influence, we assume that the salience of individual *i* for dimension *e* at time $(t+1)$, $s_{ie}(t+1)$, is the median of *i*'s own and *i*'s friends' saliences at time *t* where each $s_{je}(t)$ is weighted by $v_{ji}(t)$.

Social influence on actual and ideal-friend-values depends not only on the amount of control, but also on the saliences individuals attach to the dimensions. The amount of

control of individual *j* on *i* at time *t* is seen as the *potential* influence of *j* on *i*. Whether *j* is *willing* to mobilize his potential control to affect *i*'s value on a variable dimension, depends on how salient the dimension is for *j*. An individual's salience on a dimension is seen as the fraction of control he is willing to mobilize (Stokman and Van den Bos 1992). The ideal and actual value of individual *i* on (variable) dimension *e* at time (t + 1), $x_{ie}(t+1)$ and $y_{ie}(t+1)$ respectively, are obtained by taking the median of *i*'s own and *i*'s friends' values at time *t* where each $x_{je}(t)$ and $y_{je}(t)$ are weighted by $w_{ji}(t)$:

$$w_{ji}(t) = \frac{s_{je}(t)\, v_{ji}(t)}{\sum_{j=1}^{n} s_{je}(t)\, v_{ji}(t)} \qquad (6)$$

The above reflections on the determining elements for influence processes and the derived definitions can directly be used in simulation models. One of the ever-returning questions is whether friends tend to be likeminded because of selection or contagion. In other words, do friends select likeminded friends or do friends become likeminded through their frequent interactions? As in empirical settings both processes are difficult to disentangle, dynamic process simulation may help to separate the effects of selection and contagion on friendship structures in equilibrium. In a forthcoming study, Stokman and Zeggelink (forthcoming) will show, for example, that contagion will substantially increase segregation in friendship networks. Van Duijn et al (2003) show that these reflections are also useful for the derivation of hypotheses in empirical research and as yardsticks for questions in friendship studies.

Conclusions

We find three broad modes of influence processes in the literature: contagion, exchange and power. For each, models have been devised but researchers neglected the important question under which condition which mode is more likely to take place. The models are, consequently, around as universally valid models, but they aren't. In this paper, I argued that each mode can be seen as a cognitive frame and I specified the conditions under which the contagion frame is likely to occur by a careful analysis of the process

underlying contagion. Existing contagion models never did that and are strongly driven by the statistical elegancy of spatial autocorrelation. On the basis of a careful analysis of influence processes in policy networks and friendship networks, I specified domain specific influence models that are based on theoretical elegancy rather than statistical elegancy. The specified models show both similarities and differences with spatial autocorrelation models. Moreover, they give important directions for further specifications of the targets of influence and for specification of important parameters, like the influence weights. Like in spatial autocorrelation models, social influence is defined as a process that operates through a matrix of weighted influence relations where the total incoming influence on an actor sums to 1. Our influence definitions are also a generalization of that of French (1956) (namely if all r_{ij}'s are equal to 1, assuming we would not take the median but the mean value). Our approach has, however, an important advantage above the existing spatial autocorrelation models, namely that the weights in the matrix, including those on the diagonal, are theoretically derived and can easily be determined in empirical research. Another important difference with the spatial autocorrelation models has to do with their assumption that only a certain part of the individual's characteristics is socially determined, whereas the remainder is determined by individual characteristics. The size of the socially determined part depends on a parameter α. It should be realized that α is a system parameter that does not dependent on the individual. In our approach the individual is neither completely determined by his social environment. His resources over himself (the diagonal values in the weight matrix) determine his resistance to social influence. These values vary over individuals, depending on how much importance the individual attaches to these characteristics and how satisfied he is with their values. In addition, social influence is limited in our model because individuals attach little weight to others that deviate strongly from their ideal-friend-values on highly important dimensions. By modeling the limitation to social influence in this way, our models are much stronger related to social comparison theories than spatial autocorrelation models.

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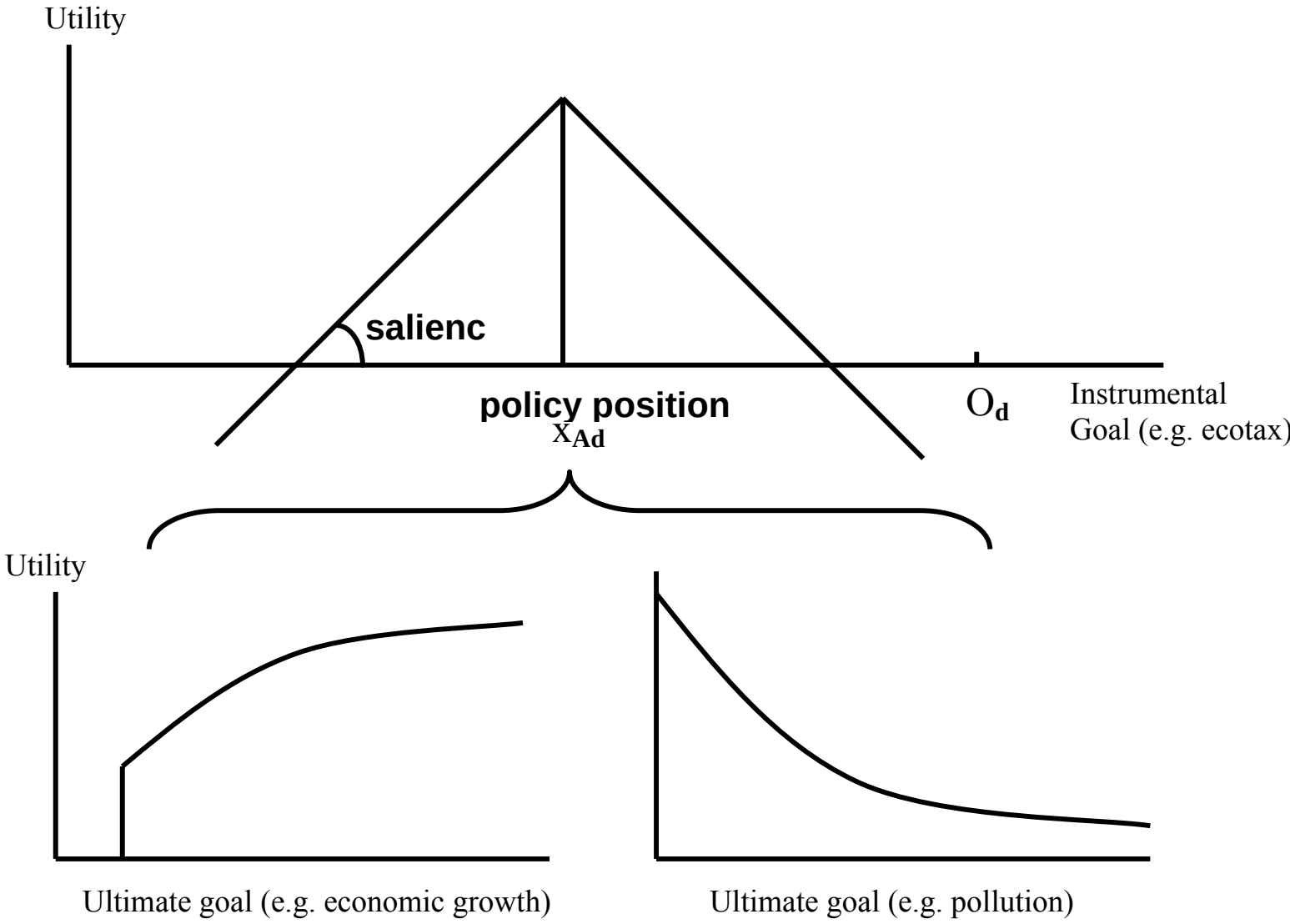

Figure 1: Utility functions of Instrumental (upper part) and ultimate goals (lower part)

[i] Whenever we refer to an individual in the male form, we mean to refer to the female form too.

[ii] In the literature the weight of the influence relation from *i* to *j* is often denoted by w_{ji}. The reader should be aware that in this paper v_{ij} does not refer to the influence from *j* to *i* but that from *i* to *j*.

[iii] This section is based on collaborative work of Evelien Zeggelink and myself, particularly Stokman and Zeggelink (1996) and a forthcoming article on effects of selection and influence in friendship networks. First empirical results can be found in Van Duijn et al. (2003).

iv This is not surprising because equality plays an important role in a potential relationship. It is easier to treat a similar individual as an equal than a dissimilar individual. Moreover, similarity is reinforcing in itself, it provides a good basis for assuming positive outcomes in subsequent interactions, it makes communication easier and it justifies the self. Similarity is particularly important for behavioral confirmation, as similar individuals tend to behave in a similar way (Lindenberg 1990).

v As c_{ij} and the next concepts are directly related to the social influence process in each iteration, we explicitly formulate in the coming equations which elements are time-dependent or not. The pair-dependent resources r_{ij} are time dependent when the individual s values on one or more dimensions (salience, ideal-friend-value, and/or actual value) are subject to social influence.