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Modeling Micro-Macro Relationships: Problems and Solutions

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This article discusses several problems of the micro-macro model, as it is depicted in its simplest form as the Coleman scheme. There is a macroproposition, its independent variables have causal effects on independent variables of a micro-theory, and the dependent variable of the micro-theory has a causal impact on the dependent variable of the macroproposition. This scheme is used to identify the basic possible problems of micro-macro modeling which are then discussed. Strengths and possible weaknesses of a wide version of the theory of rational action are analyzed. The article further provides a detailed analysis of the relationships between the micro- and macro-level.

Keywords: collective dynamics, methodology, rational choice

1. INTRODUCTION

The rational choice approach or, as we prefer to call it, the structural-individualistic research program (SIP), is by now one of the major theoretical paradigms in sociology and in the social sciences in general. The basic idea is that macro-*phenomena* (such as revolutions or inequality) as well as *macropropositions* or macro-*relationships* (such as "the larger a group, the less likely is the provision of a public good") are the outcome of the behavior of individual actors. Since this article focuses on *macropropositions,* it is useful to illustrate the basic idea of the SIP with the group size proposition, which claims that there is a negative relationship between group size and the likelihood that

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a public good is provided by the group (Olson, 1965). To explain the provision of a public good (i.e., the dependent variable of the macroproposition) means to explain individuals' contributions to a public good (e.g., refraining from polluting). These individual contributions add up to the public good (a clean environment). Why is group size, the independent variable of the macroproposition, related to the public good? If public goods provision is the outcome of individual behavior, then group size must influence this behavior or its determinants. For example, membership in a large group may reduce individual incentives to contribute to the public good because the influence of members of a large group on the provision of the public good is negligible. This example illustrates that the explanation of a macroproposition draws on individual behavior and its determinants. Proponents of the SIP apply a theory that specifies the determinants of individual behavior in a general way: this is at present rational choice theory.

This example illustrates that the SIP implies micro-macro modeling: the variables of the macropropositions are linked to the micro-level. Proponents of the SIP hold that collective phenomena *can* be explained by a theory of individual behavior. In addition, the claim is that collective phenomena *should* be explained by drawing on the micro-level because this is a theoretically fruitful strategy.

For limitations of space we will not discuss the SIP and the arguments that have been proposed in its support in any detail (see, e.g., Boudon, 1981; Coleman, 1990; Hedström, 2005; Esser, 1993; Opp, 1999, 2009; Udéhn, 2001, 2002; Vanberg, 1975; Wippler and Lindenberg, 1987). For reviews, see Hechter and Kanazawa (1997) and Voss and Abraham (2000). Nor will the extensive critique of the SIP be discussed (see, e.g., Archer and Tritter, 2000; Coleman and Fararo, 1992; Elster, 2007; J. Friedman, 1995; Green and Shapiro, 1994). Finally, it is assumed that explaining macro phenomena by drawing on the behavior of individuals is a legitimate goal in the social sciences.

George C. Homans (1958) is the founder of the SIP in sociology with his article "Social Behavior as Exchange" (see also Homans, 1974). The idea of an individualistic social science is much older: it can be traced back to the Scottish moral philosophers of the 18th century (for details, see Udéhn, 2001, 2002; Vanberg, 1975, ch. 1; Bohnen, 2000).

In the following some unresolved problems of the SIP are discussed and possibilities to solve these problems are suggested. This article begins with a brief description of how macro-phenomena are explained in the SIP, mainly by micro-macro modeling. Then, the micro-macro model as it is typically presented in the literature will be outlined which allows identification of *possible* problems of micro-macro

explanations. We will then discuss to what extent these possible problems exist and, if they exist, how they can be resolved or at least remedied.

2. STRUCTURE OF THE MICRO-MACRO MODEL

Explaining macropropositions by means of a theory about individual behavior implies that there are two kinds of propositions: one at the macro-level, the other at the micro-level. The explanation requires that the concepts of both levels are related. Figure 1—the Coleman scheme (Coleman, 1990, p. 8, but see already McClelland, 1961, p. 47)—illustrates this. The macro-level (arrow 1 of Fig. 1) consists of Max Weber's (1958) proposition that Protestantism has influenced the development of capitalism. The proposition at the micro-level (arrow 2) claims that values influence economic behavior. In order to explain the macroproposition by applying the micro proposition, it is necessary that the concepts of the two propositions are connected (see arrows 3 and 4). It is important to note that in the Coleman scheme all relationships between the variables are empirical and causal. This is symbolized by the arrows. This is the typical structure of the model in the literature, as the textbook by Esser (1999, p. 17) and a programmatic article on "analytical sociology" by Hedström and Udéhn (2009, p. 33) illustrate. The explanation of the macroproposition is that Protestantism led to the development of capitalism because the Protestant religion changed certain values which, in turn, influenced economic behavior; this behavior then had a positive impact on the origin of capitalism.

The relationships between the macro- and micro-level are often called *bridge assumptions*. This expression thus refers to macro-to-micro-relationships (arrow 3 of Figure 1) as well as to micro-to-macro relationships (arrow 4). The latter are sometimes called "transformation rules" or "aggregation rules," whereas the expression "bridge

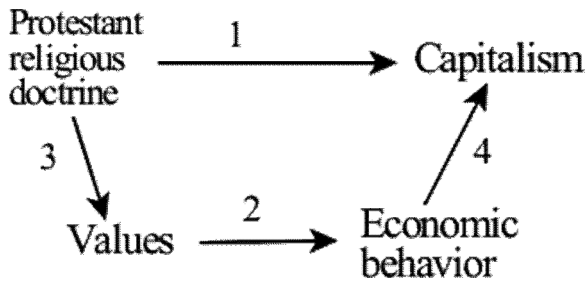

FIGURE 1 The basic micro-macro model: The standard example (Coleman, 1990, p. 8).

assumption" only refers to macro-to-micro relationships. Since some of the following arguments refer to both types of relationships, it is useful to have a single expression, that is, *bridge assumption*. When referring to one of the two types of bridge assumptions, the term macro-to-micro assumptions (arrow 3) or micro-to-macro assumptions (arrow 4) is used. The model exhibited in Figure 1 is called a *micro-macro model*.

The term *theory* is reserved for general empirical statements that are not restricted to any time and place. *Proposition* refers to general as well as singular *empirical* statements. Such an overarching term is necessary because it is not clear at this point whether macropropositions are general (lawful) or singular (empirical) statements. *Assumptions* refer to any (empirical or analytical) statements. This term is necessary because it will be discussed whether bridge "assumptions" are empirical or analytical.[1] Thus, "propositions" are always empirical statements, whereas "assumptions" may be empirical or analytical statements.

3. POSSIBLE PROBLEMS OF MODELING MICRO-MACRO RELATIONSHIPS

Before discussing problems of the SIP, it is useful to ask what are the *possible* problems. They can be identified by means of the basic micro-macro model of Figure 1. Figure 2 shows this model again, but this time the figure highlights possible problems, including:

1. In regard to the *micro-theory,* which is typically the theory of rational action, two problems will be discussed: Is the theory valid and can it explain sociologically relevant phenomena?
2. In regard to the *macropropositions* the question arises: Are they really *causal* propositions (as is suggested in the typical causal diagrams in the literature and in Figure 1 as well)? Or are they correlations? Are they *singular* propositions; that is, do they refer to certain times and places, or are they *theories*? If they are theories: What kind of theory are they and are they valid? What is the explanatory power of macropropositions; that is, how specific are the phenomena that can be explained?
3. Finally, the logical status of the *bridge assumptions* needs to be analyzed. The typical charts (Figs. 1 and 2) always assume that there are macro-to-micro and micro-to-macro *causal* relationships. But there is no doubt that bridge assumptions may be analytic, that

[1]This article presupposes some knowledge about the philosophy of science, in particular about explanation and concept formation. See, for example, Little (1991) and the classical work by Hempel (1952, 1965). A useful general introduction is Ladyman (2002).

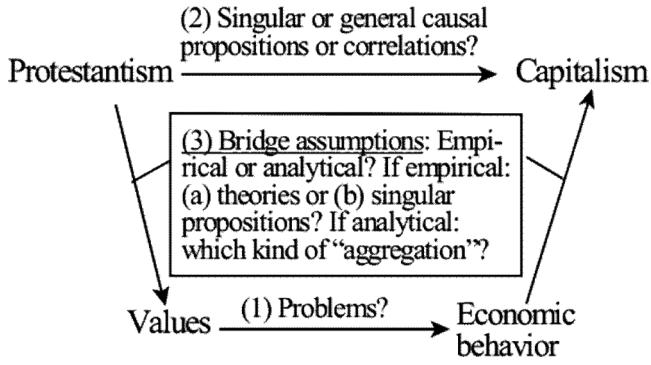

FIGURE 2 Possible problems of a micro-macro explanation.

is, logically true. For example, in explaining the crime rate of countries the individual crimes (micro-level) are certainly not a *cause* of the crime rate (a macro-property). There is clearly an analytic or logical relationship between the micro- and macro-level. If bridge assumptions are empirical: Are they singular propositions or general propositions (i.e., theories)? If they are singular propositions, which theories can be applied to explain them? In applying the Hempel-Oppenheim logic of explanation (for references, see fn. 1), the causes of the singular propositions are the initial conditions and the effects are the explananda. If the bridge assumptions are theories, the question as to what kind of theory they are emerges. For instance, can the theories be taken from the existing corpus of theories in the social sciences? If the bridge assumptions are analytical, what are the aggregation rules that are applied? Since there are currently no clear or convincing answers to these questions in the literature, it is important to elucidate these issues and discuss potential solutions.

4. IS RATIONAL CHOICE THEORY AN ACCEPTABLE MICROFOUNDATION?

Rational choice theory (RCT) is the standard theory applied by proponents of the SIP. Yet it also seems to be the most problematic component of the SIP. However, most of the critique is based on misunderstandings. For example, it is often held that RCT implies that individuals calculate. Rather, RCT only claims that human behavior is governed by costs and benefits; there need not be calculation. As Gary Becker (1976, p. 7) emphasizes, "[T]he economic

approach does not assume that decisions units are necessarily conscious of their efforts to maximize or can verbalize or otherwise describe in an informative way reasons for the systematic patterns in their behavior" (see also M. Friedman, 1953, who shares this view). Herbert Simon's idea of "bounded rationality" is consistent with this view as well (although he differs from Becker's and M. Friedman's approach in other respects): "Rationality is bounded when it falls short of omniscience. And the failures of omniscience are largely failures of knowing all the alternatives, uncertainty about relevant exogenous events, and inability to calculate consequences" (Simon, 1979, p. 502). Such misunderstandings will not be addressed here so that attention can be directed toward discussing criticisms which are to be taken seriously: (1) the theory is wrong, (2) including a variety of costs and benefits is ad hoc, (3) RCT is tautological, and (4) the theory cannot explain the phenomena in which sociologists are interested.

4.1. The Theory Is Wrong

Rational choice theorists probably share the view that RCT has been falsified by the so-called anomalies (see, in particular, the work of Kahneman and Tversky, e.g., 2000, and the summary and discussion by Frey and Eichenberger, 1991).[2] An example is the anomaly of "sunk costs." These are costs that have occurred in the past and are thus "sunk." They should play no role in present decisions because only costs that are expected to occur if certain decisions are made (i.e., prospective costs) should matter. According to traditional microeconomic theory, it is not "rational" to base decisions on such retrospective costs. To illustrate, assume that a person has bought an opera ticket for $100. He or she has then read negative reviews and would prefer not to go to the opera at all. Thus, if the person would not have bought the ticket, he or she would stay home. Many persons would nonetheless go to the opera: they will reason that they had paid for the ticket, and it would be wasted money to

[2]Some critics of RCT argue that the theory is not testable at all. The most straightforward way of testing RCT is by comparative statics (see, e.g., Lichbach, 2003, pp. 33–41; Lovett, 2006, p. 250), which is typically applied in economics: assume the model predicts a certain outcome (e.g., a decrease in voter turnout) if some parameter changes (e.g., an increase in the costs of participation in an election). The respective model is only confirmed if the changes are in the direction the model predicts. The references regarding the anomalies clearly show as well that RCT is testable; otherwise, it could not be regarded as wrong.

let the ticket expire. They thus take the sunk costs into account in their present decision. In such situations utility is not maximized, contradicting the theory.

Is the fact that sunk costs influence the decision of the person really a falsification of RCT? This question is difficult to answer because there are different versions of the theory. In prior work I have distinguished between a narrow and a wide version of RCT.[3] A *narrow* version assumes objective utility maximization (taking the perspective of an omniscient observer), complete information, and the relevance of only material costs and benefits. This version is not in line with the sunk costs finding. But the effects of sunk costs are readily explained with a *wide* version of the theory, which assumes that beliefs (which may be wrong) and not objective phenomena are the direct determinants of behavior, and that all kinds of preferences (including internalized norms and altruism) may influence behavior. This is a social psychologically oriented version of RCT that is compatible with value-expectancy theory, a widely used theory in social psychology. For example, in contrast to a narrow version, it is held that acting according to internalized norms such as fairness norms is beneficial, whereas breaking internalized norms is costly. Findings of the ultimatum and dictator games (see, e.g., Henrich et al., 2004) are in line with such a wide version of RCT. As far as sunk costs are concerned, a wide version would include sunk costs if they were actually considered by the actors. The anomaly of sunk costs is thus not problematic for a wide version of RCT.

4.2. Including a Variety of Costs and Benefits Is Ad Hoc

The second criticism states that the inclusion of additional preferences and constraints in a wide version is an ad hoc extension of RCT (see, e.g., Green and Shapiro, 1994, pp. 85–86). In its general formulation, the theory asserts that preferences and constraints affect behavior and that people choose the best alternative. This general formulation is in line with the theory that the founders of an individualistic social science such as Adam Smith have implicitly applied. It actually refers to a multitude of preferences and constraints. In addition, it is also compatible with the formulation that beliefs about the constraints (and not the objectively given constraints if they are not perceived) matter. Thus, a wide version of

[3]For a characterization and detailed discussion of these versions, see Opp (1999); advocates of a wide version are, for example, Boudon (e.g., 1996), Esser (e.g., 1999), Hedström (2005), and Simon (e.g., 1983).

RCT retains the features of a general formulation of RCT. The argument that extending the relevant preferences and constraints is ad hoc could be reversed: assumptions that certain incentives (such as norms or altruism) do not matter or that reality is always correctly perceived are ad hoc.

In regard to empirical tests or applications of the extended version to concrete explanatory problems, it must be determined empirically whether propositions about initial conditions in explanatory arguments (e.g., the claim that certain beliefs and preferences are given) are valid. When this determination does not occur, and the existence of initial conditions is simply assumed, claims about the relevance of any costs and benefits as explanatory variables become arbitrary, that is, ad hoc.

4.3. RCT Is Tautological

Another major critique of RCT is that it is tautological. A statement is, by definition, "tautological" if its truth can be determined by analyzing the meaning of its terms. RCT refers to incentives on the one hand and behavior on the other. Thus, any hypothesis about the influence of incentives on behavior has empirical content and is clearly not tautological (for details, see Opp, 1999).

4.4. How to Deal with a Problematic Theory

Detailed theoretical analyses and new empirical tests are necessary to determine whether the other anomalies and other research findings that do not confirm a narrow RCT version are consistent with a wide version. My expectation is that empirical tests will show that anomalies will not refute a wide version of RCT.

Although more research is needed to determine whether the anomalies and other research findings that do not confirm a narrow RCT version are consistent with a wide version, let us assume that there are falsifications of the wide version as well. What can be done in such a situation? One possibility is to try to modify the theory or replace it with a superior theory. The modification of a neo-classical, narrow version by adopting a wide version actually is such a modification. Another option is to abandon the theory and no longer apply it. If the latter reaction would be chosen for all falsified theories, no theory in the social sciences would be left over. This radical option is only meaningful if a better theory exists or if a theory has only been falsified and is expected not to provide any valid explanation. However, proponents of RCT argue that it provides a great number of correct

and new explanations. It is thus useful to apply RCT for the time being, until a better theory is found, despite existing problems.

4.5. RCT as an Explanation of Sociological Phenomena

The last problem to be discussed in this section revolves around the question of whether RCT is capable of explaining all the phenomena in which sociologists are interested. The theory explains actions, but sociologists are also interested in explaining beliefs and preferences that are independent variables of RCT. A frequent objection is that *second-order theories* (i.e., theories that explain the independent variables of RCT) are missing.

One rejoinder could be that sociologists do not dispose of these theories either. This is not a satisfactory response since it means that the SIP shares a problem with sociology. It is preferable to think about how to provide explanations of beliefs and preferences. One possibility is to expand the explananda of RCT so that it encompasses beliefs and preferences. This would imply that the concept of "action" is used in a wide sense, referring to "inner and exterior conduct" ("inneres und äußeres Tun"), as Max Weber (1962) has put it (see *Soziologische Grundbegriffe* [*Basic Sociological Concepts*], § 1).

Applying the theory to explain cognitive beliefs would imply that whether beliefs change or are acquired depends on costs and benefits. For example, underestimating the likelihood of being punished is costly if, as a consequence of this incorrect belief, actors do not embrace sufficient safety precautions when committing crimes. Holding the incorrect belief that punishment is unlikely is thus costly. For law-abiding citizens, however, overestimating the likelihood of punishment is not costly because there is no action that could disprove the belief. Here RCT would imply that the beliefs would not change.

Having certain preferences might be beneficial or costly as well. Assume a person has a strong aversion to interact with another person and then realizes that this person has many positive features. This situation is dissonant with the individual's current preferences and thus costly. Therefore, it seems plausible to expand the range of application of RCT. The task would be to generate and test more specific propositions explaining beliefs and preferences based on RCT.

Instead of expanding RCT one could apply existing social psychological theories. For the explanation of preferences, the strongly supported theory by Martin Fishbein and Icek Ajzen (2010) is a candidate. Learning theory such as classical conditioning can be used to explain preferences as well. For the explanation of beliefs cognitive theories such as the theory of cognitive dissonance (Festinger, 1957)

could be useful. The model of frame selection (Esser, 2001; Kroneberg, 2005) might be applicable to explain preferences as well as beliefs.

So far proponents of the SIP have focused too much attention on the explanation of behavior. As a result, theoretical ideas and tests of possible extensions of RCT along the lines alluded to above are largely missing in the rational choice literature creating deficits in regard to the explanation of the independent variables of RCT.

The discussion in this section was based on a specific version of RCT. We must leave it to further theoretical and empirical analysis whether other versions are perhaps theoretically more fruitful. For example, Elster's (2007) variant of RCT includes the assumptions that there is a "rationality" of beliefs and "optimal investment in information gathering" (pp. 191–213). In our opinion, it is more useful to adopt the wide version outlined before and treat the "rationality" of beliefs and "optimal investment in information gathering" as separate explanatory problems. Another possible issue that cannot be discussed for limitations of space is that the violations of the "canons of rationality" discussed by Elster (2007, ch. 11, 12, 18, and 19) falsify the wide version. I believe this is not the case.

5. ARE MACROPROPOSITIONS SINGULAR CAUSAL PROPOSITIONS, THEORIES, OR CORRELATIONS?

The basic model of a micro-macro explanation (Fig. 1) suggests that macropropositions are causal propositions. If this is the case, they could first be *singular causal propositions,* such as "the revolution in the communist part of Germany in 1989/1990 was influenced by the liberalization of other communist countries." A second possibility is that macropropositions are *theories,* such as "the larger a group, the less likely is the provision of a public good" (Olson, 1965). Let us first discuss these possibilities.

If a macroproposition is explained in a micro-macro model, it can neither be a singular causal proposition nor a theory. The logical structure of the micro-macro explanation shows this clearly. To illustrate: Was Gorbachev's policy really a cause for the revolution in the GDR? The explanation of the respective macroproposition is that his policy changed certain incentives in the population that, in turn, changed participation in individual and, by aggregation, collective protests. Thus, Gorbachev's policy did affect the East German revolution *indirectly* by changing individual incentives. Therefore, Gorbachev's policy did not have a *direct* causal effect on the revolution. The causal effect runs over intervening variables and is thus indirect. A similar argument holds for the group size proposition. Olson's argument

(1965) can be reconstructed in the following way (for details, see Opp, 2009, ch. 3 and 4): In a large group the incentives for individual contributions to the provision of a public good are relatively low. For example, with increasing group size the influence of the individual on the provision of the good becomes negligible, creating a disincentive to contribute. Furthermore, contributing is costly, which further discourages contribution. Thus, group size has no direct causal effect on the provision of the public good. Instead, group size affects incentives, which, in turn, keep people from acting to provide the public good. In the aggregate, then, the public good is not produced. Again, group size does not have a direct causal effect on the dependent macro-variable. The group size proposition is thus not a causal proposition either.

It could be argued that the group size proposition is a theory in the sense that an indirect effect on the dependent variable holds at all times and places, but this argument is not tenable. The explanation outlined in the previous paragraph makes assumptions about the relationships between group size and individual incentives. These assumptions are not theories. For example, the perceived influence of individual actors in a large group could be high if individuals think that the group as a whole will succeed in producing the good and if the individuals misperceive group influence as personal efficacy or if they overestimate personal influence for other reasons. Furthermore, the incentives for political entrepreneurs could be substantial in a large group: they might seize the opportunity to provide additional rewards (i.e., selective incentives) to the group members because they aspire to a political career. In such situations, group size will have a positive, not negative, correlation with individual contributions. Thus, the group size proposition is not a theory because the predicted direction is dependent on context.

This leads to the conclusion that macropropositions are not causal propositions, nor are they theories. There are only indirect effects of macro-variables on other macro-variables. This might seem implausible at first sight. For example, was not the liberalization of Eastern Europe a cause for the East German revolution? One might answer this question in the affirmative if the micro part of the model is omitted. If it can be shown why the macro-relationship holds true, it becomes evident that the macroproposition is not a causal relationship. In other words, in the micro-macro model, there is no direct effect of the liberalization of Eastern Europe on the East German revolution.

Instead, macropropositions are correlations. This follows logically from the micro-macro model. It can be written as a simple causal chain, with "M" referring to the macro- and "I" to the micro-variables—assuming that bridge assumptions are causal statements (symbolized

by arrows):

$$M_1 \longrightarrow I_1 \longrightarrow I_2 \longrightarrow M_2.$$

Note that M_1 has only an *indirect* and *not a direct* causal effect on M_2. A direct effect only exists if the model is extended by

$$M_1 \longrightarrow M_2.$$

If the intervening variables I_1 and I_2 are left out, a researcher might erroneously assume a direct causal effect. But the model does not imply such an effect; there is only a correlation. This implies that the arrow between the macro-variables in the basic model (Fig. 1) is to be replaced by an arc which symbolizes a correlation.[4]

This conclusion could be refuted if it can be shown that there exist macro-theories. However, proponents of the SIP would argue that such theories have not yet been found. It seems that informative macroproposition referring to revolutions, social change, or crime rates, for example, are actually singular propositions. Maybe they are "empirical generalizations" in the sense that they refer to several cases. Nonetheless, they hold only for certain times and places and are thus singular propositions.

If this is correct a critic of the SIP could argue that in order to arrive at "deeper" explanations one might explain macropropositions by other macropropositions. The problem is that an adequate explanation in the strict sense needs a theory.[5] However, since there are no macro-theories, an adequate explanation of a macro statement at the macro-level is not possible. The only possibility is to apply empirical generalizations that are, as was said before, actually singular propositions as well since they refer to certain times or places.

[4]Lazarsfeld (1955) would speak of an "interpretation" in the sense that a relation between variables X and Y is "explained" by showing that X leads to another variable Z which, in turn, affects Y.

[5]We are referring here to the Hempel-Oppenheim scheme. As everything in the social sciences and the philosophy of science, this scheme is controversial. One objection is that an adequate explanation does not need a theory. It is not possible to discuss the vast literature about the logic of explanation in this article. The basic defense of using theories in an explanation is that without theories it is not clear how to get valid information about the explanatory factors for an explanandum. Only theories provide information about how to select the relevant causal factors from the multitude of phenomena that co-exist with an explanandum or precede it in time. The critique of the Hempel-Oppenheim scheme does not provide a satisfactory alternative. It can further be argued that there is no reason to dispense with the application of theories because the rational choice approach disposes of propositions that, to be cautious, come close to theories.

6. ARE BRIDGE ASSUMPTIONS EMPIRICAL OR ANALYTICAL?

In contributions to the SIP it is rarely discussed what kind of propositions bridge assumptions are. For example, is the relationship between Protestantism and values (Fig. 1) empirical, as the arrow suggests? This seems plausible, as Max Weber (1958) has shown in his analysis of the effects of the Protestant ethic on capitalism: the uncertainty of salvation due to the doctrine of predestination led to psychic tension which, in turn, led the members of the church to believe that occupational success was a signal for salvation. Certain elements of the Protestant belief system thus set in motion psychic processes that gave rise to certain values. In addition, some values of the actors (micro-level) may have been *identical* to the values of Protestantism. In this case, there is an *analytic* relationship.

What about the transition from "economic behavior" to "capitalism," that is, from the micro- to the macro-level? Is the economic behavior of many different individuals logically equivalent with what we call "capitalism?" If this is not the case, what exactly are the empirical micro-to-macro bridge assumptions? This question is not answered in the literature.[6]

The distinction between analytical and empirical bridge assumptions is of central importance for the explanation of specific macropropositions and their empirical test. If there are analytical relationships, there is no need to apply theories and to conduct empirical research. However, if there are empirical relationships the question must be answered as to what kind of relationships these are; whether theories can be and, if so, which theories must be applied; and what the evidence is for the existence of the empirical relationships. We will return to these questions later.

7. WHAT ARE THE AGGREGATION RULES FOR ANALYTICAL MICRO-TO-MACRO RELATIONSHIPS?

If bridge assumptions are analytical, the question arises as to how the aggregation from the micro- to the macro-level is to be carried out.

[6]This lack of clarity about the macro-to-micro and micro-to-macro relationships is also found in the other examples by Coleman (1990). The distinction between empirical and analytical bridge assumptions was already made at the beginning of the 1970s (see Hummell and Opp, 1971, p. 17, where the concept of "coordination rule" was used). See further Lindenberg (1977) and Raub and Voss (1981). This discussion has been forgotten, and there has not been a similar discussion in the English or American literature.

Aggregation is simple for variables referring to rates such as the crime rate because it is the sum of behaviors of individuals, divided by the size of the population (or an appropriate part of the population). There are no methodological rules in the literature that explicitly specify in a general way possibilities of aggregating micro-variables. In concrete research projects researchers construct the macro-variables as they think it is appropriate.[7]

A starting point for the development of such a methodology could be the classification of collective properties by Lazarsfeld and Menzel (1961; for a discussion from the perspective of the SIP, see Hummell and Opp, 1971, pp. 35–38). Collective properties are constructed here by simple algebraic operations such as computing averages. This article suggests that, in general, the aggregations might be so simple that a detailed methodology is superfluous. The analysis of the following examples supports this thesis. Sato (2006) discusses a law passed in 1970 in Japan that provides free medical care to seniors. This law led to an enormous increase of demand for medical care and to a dramatic increase of the costs for health care. The law was repealed in 1980. The collective property "demand for health care" has been constructed on the basis of a game-theoretic analysis of the options of a senior where the increased utilization of health care ("defection" and not "cooperation") was the more beneficial alternative. Since all seniors were in the same situation, the number of individual actions is the aggregate demand. Economists also derive aggregate demand and supply by simple arithmetic operations. This aggregation is probably also typical for game-theoretic analyses: given payoff, structures lead to certain outcomes such as cooperation. This means that all players (or, according to the kind of game, a subset of the players) cooperate. "Amount of cooperation" or "cooperation" of a group is thus simply the number of individuals who cooperate. If the outcome is an "equilibrium," then this means that no player has an incentive to change his or her behavior, given the choices of the other players. "A collective effect is thus the payoff vector for the combination of equilibrium strategies of all actors" (Diekmann and Voss, 2004, p. 23; translation by Karl-Dieter Opp).

[7]To illustrate, Boudon (1981) analyzes numerous interesting examples showing how individual action brings about macro-effects. Similar analyses also can be found in Raub and Voss (1981) and Esser (1993, pp. 85–140). However, a general methodology of aggregation is missing. This diagnosis is in line with the discussion of "[t]he explanation of collective effects" by Diekmann and Voss (2004, pp. 21–22), who summarize the state of the arts.

In other words, it is predicted "that each of the players chooses the Nash equilibrium strategy" (Diekmann and Voss, 2004, p. 23; translation by Karl-Dieter Opp). Again, the aggregation is simply the number of the players who choose a particular strategy. The collective "effect" is thus an analytical relationship: "equilibrium" *means* that all players behave in a certain way.

Similar procedures are found in agent-based modeling which has become increasingly popular in the social sciences (Macy and Flache, 2009; Epstein, 2006; Gilbert, 2008; Hedström, 2005, ch. 4). The units of analysis at the individual level are actors with certain preferences who face different constraints (e.g., each actor can interact only with a restricted number of other actors). The effects of preferences and constraints on the activities of the actors (such as their choice of place of residence) are then analyzed. The procedure is that for each individual or for subsets of individuals, behavioral changes are predicted or deduced. The outcome is a certain behavioral pattern (such as a distributions of individuals in regard to certain places of residence) or behavioral changes over time (such as changes in the demand for health care). The best known examples are the segregation models by Thomas Schelling (1971), where preferences for the kind of neighbors lead to segregation. The latter variable refers to a distribution of certain kinds of individuals in space.

It is more complicated if one wants to *predict* some aggregate property. For example, assume that the members (or a certain proportion of the members) of a group intend to cooperate conditionally (i.e., are willing to cooperate if others cooperate as well). The rate of cooperation that will ensue depends on various factors. For example, cooperation only starts if there is initially at least one person who cooperates unconditionally during interaction and if this person interacts with a conditional cooperator. However, the discussion in this section does not refer to any complexities of *predicting* the rate of cooperation. We concentrate only on the aggregation of *given* individual properties.

In order to test whether the claims made in this section are correct it would be important to carry out a detailed analysis of the aggregation rules that are applied in existing micro-macro models in the literature where the micro-to-macro relationship is analytical. Since an analysis of all writings is hardly possible a sample could be drawn in which 100 or so writings are analyzed which are most often cited. The goal should be to formulate in a general way methodological rules specifying how aggregation of micro-variables across individuals is and could be carried out. The result of this analysis would be a tool kit that proponents of the SIP could use in their empirical and

theoretical analyses. The analysis could also show that such a methodology is not necessary because the aggregation rules are very simple.

8. ARE EMPIRICAL BRIDGE ASSUMPTIONS THEORIES OR SINGULAR PROPOSITIONS?

This section focuses on *empirical* bridge assumptions. First, consider macro-to-micro bridge assumptions. How do we know which macro-factors have a causal impact on which micro-variables? How do we know, for example, that the macro-variable "group size" affects the micro-variable "perceived individual influence"? The same question can be asked for micro-to-macro propositions. For example, how do we know that sanctioning of particular behaviors (micro-level) leads to the evolution of social order (macro-level), that is, the institutionalization of certain norms? The literature is silent about how such questions can be answered.

If the bridge assumptions are singular causal propositions they are usually postulated ad hoc. For example, the assumption that Protestantism (macro-level) has changed certain values (micro-level) is a singular causal statement. Coleman does not provide any argument that could confirm or support this proposition. The general question thus is how empirical causal bridge assumptions can be validated.

The previous argument implies that singular *causal* bridge assumptions are problematic, but it does not imply that singular statements in general are burdened with problems. For instance, explananda or initial conditions in explanations are singular statements and components of explanations. The adequacy of the explanation does not require that the initial conditions and the explananda are again explained.

One possibility to provide evidence for empirical singular causal bridge assumptions is to apply a theory. Let us illustrate this with the proposition that Protestantism is a cause for the change of values. The cause (Protestantism) could be the initial condition in an explanation, whereas the effect (values) could be the explanandum. The task would then be to find a theory which refers to Protestantism (or to a certain kind of religion) and values. The general question is: Which theories could be applied if bridge assumptions are singular causal propositions?

It is not possible in a single article to answer this question in a general way. Some speculations, based on examples, must be sufficient. It seems plausible that empirical bridge assumptions are not theories but singular causal propositions. This holds, for example, for the proposition about the effect of group size on perceived influence to provide

the public good. As the extensive discussion of this proposition in the literature indicates, the group size proposition is not a theory, but its validity depends on many conditions. In this and other examples there are two kinds of dependent variables at the micro-level: perceptions or cognitive beliefs and preferences. In other words, the issue is to explain the influence of macro-factors on incentives, that is, on the independent variables of the theory or rational action.

As mentioned earlier, an extended version of value-expectancy theory could be applied. It is further possible to use other existing social psychological theories. For example, the effects of liberalization of adjacent countries such as Poland (macro-level) on perceived influence in the GDR (micro-level) could be explained by stimulus generalization. This is a proposition from learning theory: people generalize the effects of similar stimuli. For instance, if protests in Hungary or Poland had effects on the change of policy in these countries, then individuals generalize that this holds for the GDR as well. This explains how perceived influence of *joint* protests is formed. A further proposition can explain an increase of perceived *personal* influence. For this purpose the theory of cognitive dissonance could be applied: it would be dissonant (and would thus be psychologically costly) if a person believes that the group is successful but that the individual contribution to the provision of the public good is superfluous. High collective efficacy thus raises individual efficacy.

Similar arguments hold for the transition from the micro- to the macro-level. If actions like individual contributions to the provision of public goods are explained at the micro-level, and if the macro-variable is "institutionalization" of a norm in the sense of general acceptance of a norm, this amounts to explaining attitudes toward norms. The Fishbein-Ajzen theory discussed above could be applicable to this situation.

In general, it is plausible that empirical bridge assumptions are not theories but singular causal propositions. For their explanation, those micro-theories can be applied that are usually applied in the SIP at the micro-level. Whether this thesis is correct can be tested by detailed analyses of existing theory and research using micro-macro modeling. Such analyses should first provide a list of the micro-to-macro and macro-to-micro assumptions. In a next step, the question to be answered is whether the bridge assumptions are analytical or empirical. If they are empirical, it should be examined whether existing theories can be applied.

If bridge assumptions are not theories, it is to be expected that the relationships between the macro- and micro-level always hold only under certain conditions. An example is the relationship between

group size (macro-level) and perceived personal influence on the provision of collective goods (micro-level). If this is not a theory, it can be expected that it will not always be valid. For example, even if groups are large, there may be misperceptions and overestimation of perceived personal influence during revolutionary events. In other words, group size correlates positively with perceived influence. But sometimes the situation is perceived correctly. This might be the case for members of automobile clubs: a member will hardly believe that his or her yearly membership fee will influence the policy of the federal government. In this type of cases, group size will correlate negatively with perceived influence. Thus, the effects of macro-variables can be determined by applying theories about individual behavior.

If this is correct the following consequence holds: different bridge assumptions imply different values of the dependent macro-variables and, thus, different correlations between the independent and dependent macro-variables. These correlations depend, among other things, on the effects of the independent macro-variable on the respective independent micro-variable. Figure 3 illustrates this. Assume that the correlation between the macro-variables is unspecified—see the upper left graph A. Now consider a situation in which group size *raises* perceived influence; that is, the effect of the macro- on the micro-variable is positive (see the circled plus sign). In addition, individual influence has a positive effect on the contribution to the provision of the collective good (microproposition). Further, let there be an analytical aggregation: the provision of the public good is a positive function of individual contributions. Since all relationships in the graph are positive the correlation on the collective level should be positive too, as the upper right graph B shows. Graph A thus implies graph B.

Now, consider the lower left graph C. Again, we first do not specify the correlation at the macro-level but now allow group size to have a negative effect on perceived influence. All other relationships are identical with those in graph A. Accordingly, the macro-relationship should be negative—see graph D at the lower right. If one compares graphs B and D it becomes clear that the relationships at the macro-level depend on the kind of effect of the independent macro-variable on the independent micro-variable.

This example highlights the implausibility of the claim that there are macro-theories. This is because the relationships at the macro-level always depend on how the macro-variables influence the micro-variables. Since macro-to-micro relationships are not theories, these relationships may vary across situations. This implies that the macro-relationships will also be different in different situations.

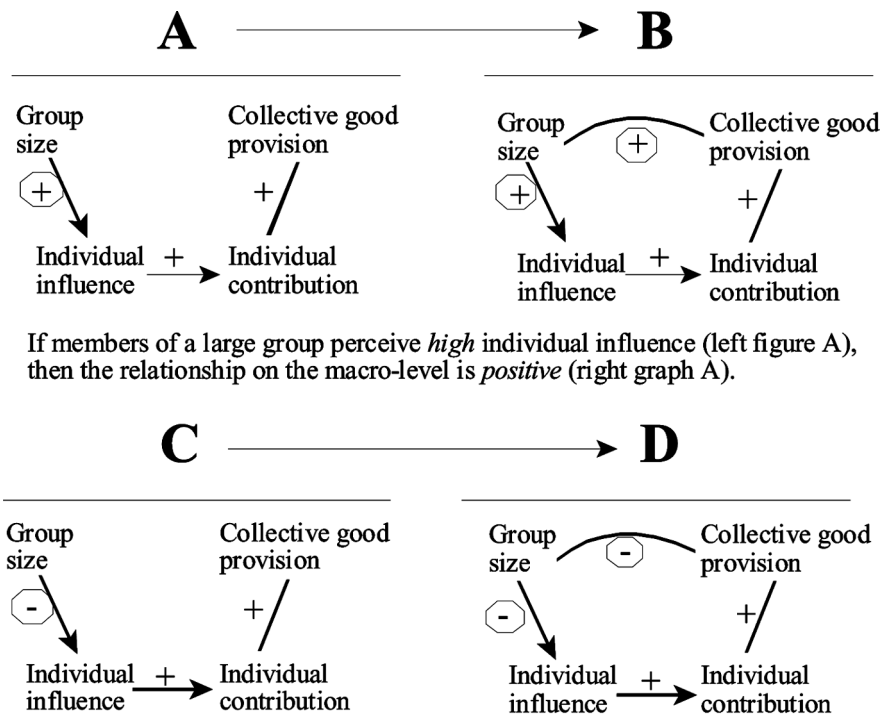

FIGURE 3 Change of a macro-relationship in case of different macro-to-micro relationships.

So far, the question of how singular causal bridge assumptions and the theories applied can be tested has not been addressed. There are no special procedures or research designs required because the bridge assumptions discussed in this section are causal statements that do not differ from other causal statements. Also, the theories used in micro-macro modeling are theories of the social sciences that have been applied in various fields and have been tested before.

Difficulties emerge if specific explanatory problems are to be solved, especially in natural situations. Take the protests in 1989 and 1990 in the former communist countries. One question is why the protests in East Germany after October 9, 1989, increased. Consider the proposition that the absence of repression on October 9 (macro-factor) had a causal effect on the expectation of the citizens that repression will not occur in later demonstrations (micro-factor), and that this expectation was a cause for the increase of protests after October 9. How could this explanatory argument be validated?

First, evidence has to be provided for the validity of the singular statements: the absence of state repression is a well-established fact. Was there an expectation after the demonstration that repression would not occur in later protests? Did the number of protesters increase in later demonstrations? Note that so far no causal statements are involved; the issue is to establish the facts. In regard to the subjective factors (expectations or preferences) survey research could help to measure expectations or goals of the population (see, e.g., Opp, Voss, and Gern, 1995). In regard to behavior (such as the number of participants in a demonstration) observation would be an appropriate method. The existence of an expectation about future repression could be tested by presenting respondents with items referring to their beliefs. How can assumptions about causality be tested? As was insinuated before, one could apply theories. In our example, the generalization hypothesis from learning theory (see before) would be pertinent. In regard to the proposition that a decrease of expected repression led to more protest, RCT suggests that a decrease of costs for a behavior increases its frequency. This hypothesis holds if no other costs for the behavior increase simultaneously. This has to be examined empirically as well.

This simplified example illustrates two important points. One is that the propositions included in a micro-macro model, in particular bridge assumptions, can be tested as any other explanatory argument in the social sciences. The second point is that theories can and should be applied in providing evidence for bridge assumptions.

9. VARIANTS OF THE BASIC MODEL

The previous argument implies that the basic micro-macro model in Figure 1 depicts only one possible micro-macro explanation—if we replace the causal arrow at the macro-level with an arc signifying a correlation. Figure 4 shows the possible variants, illustrated with the group size proposition. We first present the basic model again (as in Fig. 1). The corrected basic model where the macroproposition is a correlation and no longer a causal proposition becomes variant A.

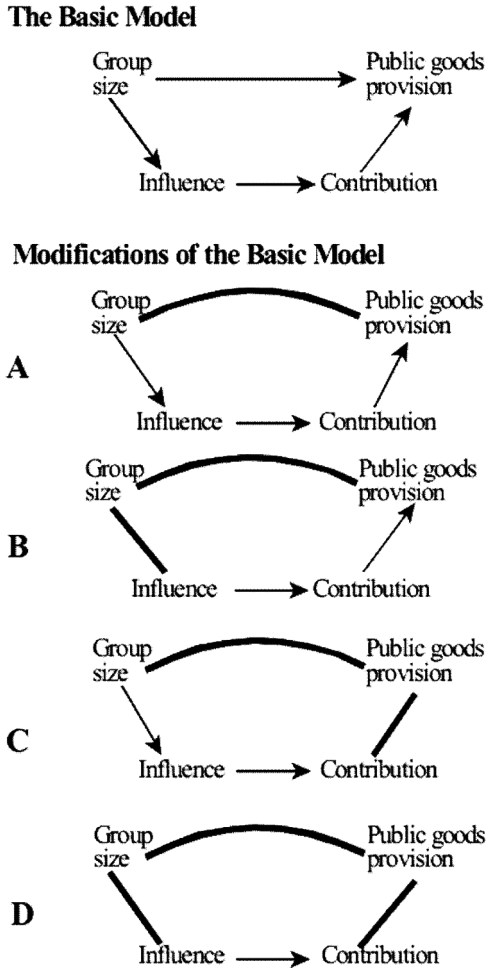

FIGURE 4 Variants of the basic model of a micro-macro relationship.

If the independent variables of the macroproposition and the micro-theory are analytically related, we get variant B. In variant C, the analytical relationship refers to the relationship from the micro- to the macro-level. In variant D both bridge assumptions are analytical. The two extreme cases in which—with the exception of the relationship at the micro-level—either all relationships are empirical or all relationships are analytical are variants A and D. In all variants, the micro-theory is the only law.

The models in Figure 4 are relatively simple: each relationship consists only of a dependent and an independent variable. In real explanations, the models are much more complicated (see, e.g., Opp, 1992). For example, there may be more than one independent variable at the macro- and micro-level, and explanations may change several times between micro- and macro-level. Due to space constraints, it is not possible to discuss these complications in more detail.

10. IS THE ''RECONSTRUCTION THESIS'' NECESSARY?

Proponents of the SIP advance the claim that concepts referring to groups or their properties actually denote individuals or their (absolute or relational) properties. For example, a "social system" or a "group" is given, by definition, if individuals interact with each other or if they share other properties such as common values (see, e.g., Parsons, 1951, pp. 3–23). Often macro-concepts such as "society" or "revolution" are not clearly defined. Nonetheless, an analysis of their meaning indicates that they can be "reconstructed" as sets of individual actors and their properties. This claim, that concepts referring to collectives actually denote individuals and their properties, is called the "reconstruction thesis."

The validity of this thesis is assumed if micro-to-macro relationships are analytical. This means that the macro-properties are (or can be reconstructed as) a function of properties of individual actors. The construction of the collective property of "institutionalization" and of rates such as the crime rate illustrates this feature. Although the reconstruction thesis is controversial, it will not be discussed in detail here. Rather, we will only ask whether it is necessary as a component of the SIP: Could not one argue that it is sufficient for a micro-macro explanation if there are only empirical bridge assumptions?

The reconstruction thesis is implicitly assumed to hold true if micro-to-macro relationships are explained by micro-theories referring to individual behavior. Such an explanation is only possible if the macro-variables can be reconstructed as (absolute or relational)

properties of individuals. The reason is that the dependent variables of the micro-theories are properties of individual actors. Therefore, the variable to be explained must be an aggregate of individual actors or their properties. To illustrate, assume that we are trying to predict how the extent of negative sanctioning directed toward smokers (micro-level) leads to the institutionalization of a nonsmoking norm (macro-level). A micro-theory can only be applied if the "institutionalization" of a nonsmoking norm refers to properties of individual actors. In other words, the "reconstruction thesis" is necessary if micro-theories are applied to explain empirical micro-to-macro bridge propositions.

Is the validity of the reconstruction thesis also required for explaining empirical macro-to-micro propositions? Again, consider the effects of group size (macro-level) on perceived influence (micro-level). The issue is the effect of a macro-variable on cognitive beliefs. If the beliefs refer to macro-properties such as the size of a group then it is not necessary that the macro-variables can be reconstructed as properties of individuals. The reason is that perception is a (relational) property of individuals and the objects perceived, and the object of perceptions may be any kind of entity, be it an individual, a group, or a material object. A disaggregation is therefore unnecessary. In general, for explanations of empirical macro-to-micro bridge assumptions it is not necessary that macro-properties are "nothing else" but properties of individuals; that is, here the reconstruction thesis need to hold true.

11. CONCLUSION AND FURTHER RESEARCH

The most important conclusion we draw from the previous discussion is that an *integration* of the seemingly conflicting research programs of an individualistic and collectivistic social science seems possible. Proponents of the collectivistic program agree that it is useful to find mechanisms referring to the micro-level that generate macro-relationships. This concession to the individualist does not seem excessive. It has been emphasized time and again by those who advance micro-macro explanations that collectivists always invoke the micro-level to make their macropropositions "understandable." However, they rarely model their implied micro-macro explanations explicitly.[8] Practically, the concession demanded means that the

[8]For example, Opp (2009) has demonstrated with numerous quotations that the major authors of the macro-approaches in the social movement literature clearly suggest micro-macro explanations without ever formulating them explicitly.

implicit micro-macro explanations proposed by proponents of macro-approaches are formulated *explicitly*. This would allow cooperation across schools by integrating the rich stock of macropropositions and the existing micro theories to arrive at deeper explanations.

This article has taken up methodological questions that are related to a literature that is rarely referred to by present-day rational choice theorists. We have in mind the philosophical debate about methodological individualism in the 1960s in which authors such as Karl R. Popper and Friedrich A. von Hayek participated (for an overview, see the reader by O'Neill, 1973). It is also important to remember the debate about "reductionism" in sociology, mainly triggered by the work of George C. Homans. It would be an interesting task to examine to what extent the existing empirical and theoretical literature of the SIP could cast new light on the theses and arguments in those debates. Perhaps, it would turn out that taking up these debates could be relevant for concrete research in the structural-individualistic research program.

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