

A Comparative Analysis of the Ethos of Science

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科學思潮에 관한 比較研究

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요 약

本 論文의 研究目的은 傳統의으로 論議되고 있는 머튼의 科學에 관한 規範들이 學界(物理學, 生物學, 社會學)에서 어떻게 認知되고 있는지 經驗的으로 實證해 보는 데 있다.

머튼의 傳統의인 科學思潮(purity, autonomy, impartiality)와 學界에 있는 科學者들 사이에서 固守되고 있는 道德의 規範들(universalism, organized skepticism, communism, disinterestedness)은 科學者들의 專攻에 따라 多樣하게 認知될 것이다. 여기서 細部의으로 檢討되고 있는 假說들은 다음과 같다.

첫째, 科學者들, 특히 物理學者들은 道德의 規範들에 대한 假定과 執着에 대한 認知도를 높게 보일 것이다. 왜냐하면 物理學은 高度의 high-paradigm을 지니고 있기 때문이다.

둘째, 生物學者들의 경우, 道德의 規範들에 대한 假定과 執着에 대한 認知도는 보통정도일 것이다. 왜냐하면 生物學의 paradigm은 moderate하기 때문이다.

셋째, 社會學者들에 있어서 道德의 規範들에 대한 假定과 執着에 대한 認知도는 가장 弱한 反應을 보일 것이다. 왜냐하면 社會學은 low-paradigm을 지니고 있기 때문이다.

本 研究를 위하여 抽出된 標本은 1977년 美國의 3개 分野에 종사하고 있는 學界科學者 들이기 때문에 政府나 產業界에 종사하고 있는 科學者들을 포괄적으로 다루지 못하여 現時點에서 어느정도 代表性을 지니고 있는지 制約을 內包하고 있다. 또한 3개 分野에 종사하는 科學者만 다루어 代表性이 약하다.

I. Introduction

Statement of the Problem

Scientific knowledge and its application through technological advances have intruded into and changed human societies in ways which have as yet eluded the comprehension of both laymen and scholars. It is somewhat ironic, therefore, that the sociology of science,

* Received October 15, 1985; accepted December 1, 1985.

Prepared for the XVIIth International Congress of History of Science, University of California, Berkeley, July 31-August 8, 1985 and is also published in the *Social Science Review*, Sung Kyun Kwan University, Vol. XXIV(1985).

the specialized area of inquiry within sociology which attempts to understand and elucidate the operation of science as a social institution, has remained relatively undeveloped and neglected. It is a field of knowledge which has been dominated by a handful of theorists who, on the whole, have dealt with the subject in a less than comprehensive manner.

The issues addressed in the research derive from the Mertonian tradition of the sociology of science. However, the present research is designed to question and to test the very basic premise of the Mertonian tradition of an undifferentiated and unchanging ethos (normative system) of science. It attempts to answer these questions: "Is the scientific ethos perceived as 'real' by scientists related to the conditions of the practice of science experienced by these scientists?" Or, "If individual scientists are exposed to different conditions of the practice of science, will they perceive adherence to the ethos of science differently?"

Sociologists in the analysis of human interaction remind us of the importance of group assumptions and norms as a guide to the behavior and subjective states of human actors. Thus, in trying to understand science as a social institution and the behavior and perspectives of scientists, we look to the normative system for the practice of science. Merton has traditionally articulated the assumptions and moral norms of science in the following manner. His ethos of science rests upon three value assumptions concerning the nature of the relationship between science and society. Specially, these are the assumptions of the purity of science, the resulting autonomy of science, and the necessary impartiality of the scientist requiring a segmentation between the individual's roles as scientist (impartial, i.e., value-free, objective, non-responsible, apolitical, etc.) and as citizen (partial, i.e., value-involved, political, responsible, etc.). The four derivative moral norms of the scientific ethos are universalism, organized skepticism, communism, and disinterestedness.

The focus of the present research is solely upon the ethos of science, or the moral norms of assumptions of science, as opposed to the technical norms of the scientific method. These moral norms and assumptions define appropriate patterns of interaction both among scientists themselves and between scientists and those who are representatives of the institutions of society.

It asked American university scientists in the disciplines of physics, biology, and sociology to what extent they perceive the Mertonian moral norms and assumptions to be operative among scientists today. The theoretical framework of the sociology of knowledge is applied to the analysis of different perspectives of the ethos of science as they are related to historical, social, and experiential conditions of the conduct of science. Specifically, it attempts to answer the question of how the differences in the phenomena which form the subject matter of various scientific disciplines and in the group socialization experiences of scientists in different disciplines affect the scientists' perceptions of the assumptions and moral norms of science and scientists today.

Justification and Rationale for Research

The current research effort may be justified as "filling a gap in the literature" in that it attempts to explore a question which no other single piece of research has explored.

It will examine scientists' perception of the entire package of the ethos of science i.e., both the assumptions of purity, autonomy, and impartiality and the norms of universalism, organized skepticism, communism, and disinterestedness. It will attempt to overcome the limitation of operationalization and sampling of earlier research through it, too, will have its own limitations.

It deals only with scientists' perceptions of "what is" and not of what "ought to be." The 519 respondents come from a sample of scientists at American colleges and universities drawn from the rosters of faculties and professional associations in physics, biology and sociology.

Limitations

1. It is limited historically. The conclusions reached are based on responses of scientists in 1977 and can not necessarily be considered representative of scientists at earlier or later periods.

2. It is limited by national location. All of the scientists included in the sample were located at American colleges and universities. The responses cannot necessarily be considered representative of scientists in other countries.

3. It is limited by institutional setting. Only academic scientists were studied. Their perceptions of science may vary from those of scientists in government or industry. (Kim, 1978)

4. Only three disciplines are being examined. Scientists in the discipline of physics, representing the physical sciences, of biology, representing the life sciences, and of sociology, representing the social sciences, have been asked to respond to the questionnaire. Obviously, their responses cannot be generalized to those of scientists of other disciplines. However, as suggested, these disciplines have been selected as illustrative of the three broad branches of science.

Because scientific discipline is the major explanatory (independent variable of the current study), perhaps a word is in order here by way of rationale. Merton never explicitly states that his paradigm of the scientific ethos applies equally to all sciences, though this is implicit. Merton's ethos is based on a physical science model and most of his illustrations come from the physical and life sciences. However, the neo-positivism of Merton's work leads one to assume that to the extent that sociology and the other social sciences are viewed as "science" — then the paradigm is to apply equally to them. This, however, cannot simply be assumed; and it is the precise purpose of the present research effort to explore variations in the ethos of science as a function of scientific discipline. Increasingly, sociologists of science (cf. Whitley, Kuhn, West, Blisset) are coming to recognize the importance of scientific discipline as a key sociological variable in the definition of what science is.

5. Lastly, the current research is limited in that it deals only with scientists' perceptions of science, as opposed to their actual behavior and/or their ideal-normative prescriptions for what science "ought to be."

The present research is derived from the Mertonian tradition of the sociology of science, but seeks to go beyond the confines of this tradition. It begins with Merton's paradigm of the ethos of science. However, rather than assuming it to be universally valid for all scientists, it makes this determination the focus of empirical inquiry.

II. Hypotheses

The major hypothesis of this study, derived from both the sociology of knowledge and the handling of the variable of scientific discipline and the paradigm concept in the sociology of science (Mannheim, 1936; Merton, 1973; Whitley, 1972; Kuhn, 1962, 1970; Blissett, 1972; Hagens, 1975; Mitroff, 1974; Ritzer, 1975; Lodahl and Gordon, 1972), is as follows.

Scientists' perceptions of the assumptions of the traditional (Mertonian) ethos of science — purity, autonomy, and impartiality — and of adherence among scientists to the moral norms of this ethos — universalism, organized skepticism, and disinterestedness — will vary according to the degree of paradigm development of the scientists' disciplines.

Derivative hypothesis 1. Perception of the assumptions and of adherence to the moral norms will be greatest among physicists, whose discipline is a high-paradigm science.

Derivative hypothesis 2. Perception of the assumptions and of adherence to the moral norms will be moderate among biologists, whose discipline is a moderate-paradigm science.

Derivative hypothesis 3. Perception of the assumptions and of adherence to the moral norms will be least among sociologists, whose discipline is a low-paradigm science.

The assumptions and moral norms may be conceptually defined and described in the following manner.

Autonomy: Autonomy refers to the freedom of science from intrusions of other societal institutions — politics, economics, religion, etc. — and factors into the internal functioning of the institution of science "All restraint or control of scientific investigation is to be resisted" (West, 1960: 54).

Purity: Science is the pursuit of knowledge as an end in itself; it is nonutilitarian.

Impartiality: Because of the purity and autonomy of science, scientists are not responsible for the utilitarian implications and applications of scientific knowledge. This nonresponsibility has been defined as "impartiality: a scientist concerns himself only with the production of new knowledge and not with the consequences of its use" (West, 1960):

Universalism: Truth must be evaluated in terms of preestablished impersonal norms consistent with observation and previously established knowledge and without regard to nationality, creed, class, etc. Objectivity requires universalism. Universalism refers to the "absence of bias: the validity of a scientific statement depends only on the operations by which evidence for it was obtained, and not upon the person who makes it" (West, 1960: 54).

Organized Skepticism: Scientists must be detached and must suspend judgment until all the data is in and has been evaluated in accordance with the other technical and moral norms of science. Organized skepticism refers to "suspension of judgment: scientific statements are made only on the basis of conclusive evidence" (West, 1960: 54).

Communism: Scientific knowledge, which is the product of community effort, is held in common ownership by the scientific community. There must be open communication of all scientific findings. Scientists are, therefore, concerned with priority in discovery, peer recognition and esteem. "Scientific information should be available to all who wish to have it. Private property rights are reduced to credit for priority of discovery; secrecy thus becomes an immoral act" (West, 1960:54-56).

Disinterestedness: Scientists must act with moral integrity and not exploit their work for personal gain. "Men are expected to achieve their self-interest in work satisfaction and in prestige through serving the community interest" (West, 1960:54).

Merton and those in his tradition (e.g., Barber, Storer, Zuckerman, Cole, etc.) assume a monolithic and virtually unchanging ethos of science, and focus on the internal dynamics of science and interaction among scientists, especially the "reward system." This selective focus ignores, or worse, obfuscates the interface of science with the total fabric of society — the institutions of technology, politics, industry, military, education, family, and religion — and the impact of this interface upon group meanings of science.

Moreover, Merton and his colleagues have, for the most part, merely assumed these assumptions and moral norms to be the guide for all scientists in the conduct of their research and research-related interaction among one another. While such an assumption may have been warranted in an earlier period of history when science was dubbed "little science," there is a serious question of such an assumption in today's period of "big science."

Storer (Merton, 1973: xviii-xix) observes:

Widely adopted as it has been, Merton's description of the "ethos of science" has not, it should be remarked, met with universal acceptance over the thirty years since its publication. Criticism, however, has been concentrated not so much on its having mistaken the components of this ethos, but on the question of whether these norms in fact guide scientists' everyday behavior. No one has come forward with a radically different set of norms, but various critics have pointed out that scientists frequently violate one or more of the indicated norms...

The theoretical problem is one of identifying the conditions under which behavior tends to conform to norms or to depart from them and to make for their change...

Thus, there is a growing body of literature which questions the validity and existence of the assumptions and moral norms of the Mertonian ethos of science in the contemporary institution of science and its interface with other social institutions.

III. Methodology

Population Universe: The Independent Variable — Scientific Discipline

The population universe is composed of scientists with the Ph. D degree in physics, biology, or sociology who belong to their respective professional associations and/or who are employed in American universities and colleges. Both the decision to study only scien-

tists working primarily in the academic setting and the decision to include those in the fields of physics, biology and sociology were based on a combination of pragmatic and theoretical factors. First, it was decided to focus on a single site of employment. This decision, it was hoped, would produce a relatively homogeneous population, at least with regard to work site, and would eliminate this variable as an alternative explanation for differences found among disciplines.

Sampling Design

The sampling design employed is a variation of a systematic stratified sample with a random start (Babbie, 1973: 91-95). The faculty directory of physicists and the membership lists of biologists and sociologists each constituted a stratum. An equal number of elements was drawn from each stratum rather than a number proportional to the different number of elements in each stratum. Since the lists for the three disciplines varied in size, the sampling ratio and the sampling interval for each discipline or stratum varied accordingly (Babbie, 1973:92-93). In drawing the systematic sample, only scientists with the Ph. D. degree currently employed in American colleges and universities were included. Checks on discipline, degree, and employment were confirmed from the responses of the scientists to questionnaire items requesting this information.

The total sample size was 1,200 and contained 400 scientists from each field. A large sample was drawn to insure a sufficient number of returns from the initial mailing so that a costly second mailing could be avoided. As anticipated, 519 usable responses were received. This total included 139 physicists, 166 biologists and 214 sociologists. The 519 returned questionnaires, which has been pretested, represent a response rate of 43.3%, which is generally considered acceptable for statistical analysis of mail surveys.

The Questionnaire Instrument: The Dependent Variable — The Scientific Ethos

The questionnaire instrument, divided into three sections, was designed to provide factual information about the scientist and his/her work (Section III), as well as information regarding scientists' beliefs about the extent of realization of the Mertonian ethos in the practice of science today (Section I), and scientists' attitudes vis-a-vis this ethos as a prescriptive guide to scientific activity (Section II). The format of Section I and II on beliefs and attitudes consisted of Likert-type fixed-choice items. Each statement was accompanied by five choice categories: strongly agree, agree, no opinion, disagree, and strongly disagree. Items were formulated to tap dimensions of the seven components of the scientific ethos, i.e., the assumptions of purity, autonomy, and impartiality and the moral norms of universalism, communism, organized skepticism, and disinterestedness. It is the scientists' perceptions of adherence to these assumptions and moral norms in the contemporary institution of science which is the dependent variable in the study. The items were scored so that a response of strongly agree signified perception of greatest adherence to the Mertonian ethos and strongly disagree signified the least. Section III, requesting personal and positional background information, contained both a fixed-alternatives and open-ended items.

IV. Findings

1. Analysis of the Autonomous System of Science

The autonomous system of science rests upon the triple assumptions or values of scientific purity, autonomy, and impartiality. Recall that purity specifies that science is the pursuit of knowledge as an end in itself. It is inextricably intertwined with autonomy, which defines the institution of science as being free from interference or considerations of personal values, politics, religion, ideology, etc. Finally, impartiality (similar to rationality and emotional neutrality) indicates the necessary detachment of the scientists from his/her work and the resultant lack of responsibility for any technological applications or uses of scientific knowledge. The scientist is motivated solely by "purely scientific" considerations, i.e., those which relate to additions to or modifications of scientific knowledge.

(1) *Scientific Purity*

Whether or not scientists perceive science as "pure" or "nonpure," i.e., value-oriented, is crucial for their total perspective of the scientific ethos. Views about scientific purity are perhaps the most strategic of all those to be considered. For purity is the cornerstone upon which the edifice of the scientific ethos is constructed. If it is shaky, it affects the stability of the entire structure. The analysis begins with scientists' perceptions of this essential assumption.

The response patterns among disciplines for the assumption of "scientific purity" fit neatly into the anticipated or hypothesized patterns. (See Table 1) The largest proportion of physicists are found in the high support category (36.7%), providing evidence of their greater, though far from unanimous, belief in the existence of a "pure" science. The smallest proportion of physicists (28.8%) are found in the low support category, indicating that a sizeable minority of these scientists perceive a "non-pure" science. For sociologists, the opposite pattern emerges from the findings. The largest proportion fall into the low support category (42.1%), while the smallest proportion fall into the high support category (26.6%). More sociologist perceive science to be "nonpure" than "pure." The response pattern for biologists is intermediate between those for physicists and for sociologists.

Table 1. Perception of Scientific Assumption of Purity, by Discipline

Degree of Perceived Support	Discipline		
	Physics	Biology	Sociology
High	36.7%	28.9%	26.6%
Moderate	34.5	34.3	31.3
Low	28.8	36.7	42.1
	100.0	100.0	100.0
N	(139)	(166)	(214)

F=3.730 Significance at the .024 level

Biologists are found in the high support category in only slightly greater proportion than are sociologists (28.9%). But, the remaining majority are almost evenly divided between the moderate support category (34.3%) and the low support category (36.7%). They, too, see science today as essentially “nonpure.” Clearly, physicists offer greatest support for the assumption of scientific purity, sociologists offer least support, and biologists offer moderate to low support. These findings are significant at the .02 level.

In opting for a science which is goal or value-oriented as well as pure, scientists have denied the total insulation and isolation of science from its external societal context. They have established a basis for further rejection, at least partial, of the assumptions and norms of the scientific ethos. Finally, they have called into question the appropriateness or applicability of the classical, Mertonian, ethos of science.

(2) *Scientific Autonomy*

The issue of scientific autonomy, a key assumption of the Mertonian ethos, has dual dimensions corresponding to the internal and external systems of science. These dimensions encompass a consideration of external autonomy — autonomy vis-a-vis external institutions (e.g., government, military, industry, private foundation and internal autonomy — autonomy vis-a-vis internal constraints (e.g., disciplinary boundaries, training, peer evaluation). The patterns of response for the autonomy index reveal an even greater degree of differential support among scientific disciplines in the direction predicted. (See Table 2)

Table 2. Perception of Scientific Assumption of Autonomy, by Discipline

Degree of perceived support	Discipline		
	Physics	Biology	Sociology
High	46.1%	35.5%	32.5%
Moderate	33.6	38.1	25.7
Low	20.3	26.4	41.8
	100.0	100.0	100.0
N	(128)	(155)	(206)

F=7.794 significance at the .001 level

As expected, physicists are found in the greatest numbers (46.1%) in the high support category, indicating their perceptions of relatively more autonomy in science today. These numbers reduce to 33.6% in the moderate support category and only 20.3% in the low support category, corresponding to perceptions of much less autonomy. Fewer biologists than physicists, though still more than a third (35.5%), responded with high support. Slightly more, 38.1%, gave moderate support and even fewer, 26.4% evidenced low support. Thus, biologists, in comparison with physicists, offer generally less support for the Mertonian assumption of scientific autonomy.

As anticipated, sociologists are found predominately in the low support category (41.8%). Significantly, this proportion is twice as great as that for physicists in the low category.

Only 32.5% of sociologists are in the high support category, representing a considerably smaller proportion than that of physicists. The remaining sociologists (25.7%) responded with moderate support for autonomy. The differences disciplines with regard to perceptions of autonomy in science are sharply drawn. Most physicists perceive greatest autonomy and high support for the ethos, most biologists perceive moderate autonomy and moderate support, and most sociologists perceive least autonomy and low support for the Mertonian ethos. These findings are significant at the .001 level.

A general consensus emerges among all scientists that contemporary science and scientists are not fully autonomous, with physicists perceiving somewhat greater scientific autonomy to exist than do biologists and particularly sociologists, who appear to be cynical in their assessments of autonomy. Scientific autonomy was felt to be especially limited by decisions made in funding agencies and by relations with governmental, military, and corporate institutions. These data raise serious doubt about the perceived validity of the assumption of scientific autonomy of the Mertonian ethos. They further erode the foundation of this ethos of science.

(3) *Scientific Impartiality*

Impartiality is the assumption of value-neutrality vis-a-vis the external system of science, i.e., in relation to the potential consequences and uses of scientific knowledge. Nonresponsibility is the corollary derived from this assumption. Together impartiality and nonresponsibility make sense only within the context of a pure and autonomous system of science. Given the partial support for purity and the qualified support for autonomy, we would anticipate limited support for impartiality, as well. This is, indeed, what we find.

The response patterns for scores on impartiality reveal striking differences between physicistss and sociologists (See Table 3) in the direction hypothesized. While 46.8% of the physicists give impartiality high support, only 27.1% of the sociologists perceive impartiality to be high among scientists. The figures for low support are reversed. Here, 48.6% of the sociologists and only 25.9% of the physicists fall in the low support category. Only the proportions of physicists and sociologists perceiving moderate impartiality are similar (27.3% of physicists and 24.3% of sociologists). The response pattern for biologists is interesting — the smallest proportion (20.5%) are in the moderate support category. The

Table 3. Perception of Scientific Assumptions of Impartiality, by Discipline

Degree of Perceived Support	Discipline		
	Physics	Biology	Sociology
High	46.8%	41.5%	27.1%
Moderate	27.3	20.5	24.3
Low	25.9	38.0	48.6
	100.0	100.0	100.0
N	(139)	(166)	(214)

F=5.324 significance at the .006 level

remaining 80% are divided almost equally between perceptions of high (41.5%) and low (38.0%) support among scientists. It is evident from the data that a larger proportion of physicists than of sociologists perceive impartiality to be high among scientists and that, conversely, a larger proportion of sociologists than of physicists perceive low impartiality. Finally, biologists appear to be divided between high and low support of impartiality. These findings are significant at the .006 level.

Summary

The data suggest that physicists, biologists, and sociologists hold significantly different views of the degree to which the contemporary institution of science is consistent with the assumptions of purity, autonomy, and impartiality of the classical (Mertonian) ethos of science. As hypothesized, physicists, whose experiential base is within a high-paradigm field, perceive the greatest support for the ethos. Biologists, operating within a moderate-paradigm science, perceive moderate support. Sociologists, practicing within a low-paradigm field, perceive least support for the assumptions of the scientific ethos. The responses of biologists were similar to those of sociologists for purity and autonomy, but resembled those of physicists for impartiality. Regardless of discipline, it is clear from the data that scientists in this survey perceive the conduct of scientific activity today to be at variance with the assumptions of the scientific ethos.

They have consistently given only partial and limited support to purity, autonomy, and impartiality, the essential axioms of the classical ethos. In essence, these scientists have undermined the very foundation upon which the system of the moral norms of science is erected. It is these moral norms which focus primarily on the "proper" operation and modes of interaction and motivation of the internal system of science. The moral norms are designed chiefly to guarantee separation and insulation of science from its societal environment, i.e., from intrusions of personal and institutional values into its operations. To the extent that science is or is not pure, autonomous, and impartial, we would anticipate adherence or lack of adherence to the norms of universalism, organized skepticism, communism, and disinterestedness.

The data presented here point rather definitively to science's loss of innocence — at least from the perspectives of its academic practitioners. The theme echoed so frequently in the literature that science today is somehow different, e.g., it is more circumscribed, more tied to external institutions for funding, more in demand by these institutions because of past successful applications of scientific knowledge, and scientists are more reluctant to be oblivious to the consequences of scientific knowledge, is confirmed. Against this backdrop the following quotation from Merton (1973: 175) takes on heightened and ironic significance:

A principal sociological idea governing this empirical inquiry holds that the socially patterned interests, motivations, and behavior established in one institutional sphere — say, that of religion or economy — are interdependent with the socially patterned interests, motivations, and behavior obtaining in other institutional spheres — say, that of science... The same individuals have multiple social

statuses and roles: scientific and religious and economic and political. Beyond that, the social, intellectual, and value consequences of what is done in one institutional domain ramify into other institutions, eventually making for anticipatory and subsequent concern with the interconnections of institutions. Separate institutional spheres are only partially autonomous, not completely so. It is only after a typically prolonged development that social institutions, including the institution of science, acquire a significant degree of autonomy...

...The recent highly publicized discovery of the industrial-military-scientific complex only brings to our notice tendencies toward interdependence of science and other social institutions that have, to a degree, been present all along. ...

2. Analysis of the Moral Norms of Science

This section contains an analysis of the findings for the four moral norms of science: universalism, organized skepticism, communism (later renamed communality for "political" reasons), and disinterestedness. These norms are logically derived from and consistent with the prior assumptions of scientific purity, autonomy, and impartiality. The uniform patterns of differential support of these assumptions by physicists, biologists, and sociologists are excellent reasons for us to expect that scientists of these disciplines will differentially perceive adherence to the moral norms as well. Additionally, the very qualified general level of agreement with the assumptions of the scientific ethos foreshadows the limited overall support for the norms.

As noted previously, the moral norms pertain essentially to the modes of operation and interaction within the internal system of science. They prescribe neutrality, detachment, doubt, complete openness, and selflessness. They prohibit the interference of personal and/or external values with the scientific enterprise. Universalism specifies that the generation, evaluation, and publication of all scientific knowledge, theories, etc. must be "objective." That is, these processes must be conducted without regard to any particularistic factors, e.g., personal values, political ideology, ethnic or national or religious identification, social class, status, age, sex, etc. The norm of organized skepticism stipulates, in a related fashion, that scientists must maintain a posture of skepticism, i.e., of doubtful criticism and detachment vis-a-vis the acceptance of findings as supportive of conclusions and/or as confirming a given hypothesis or theory. This posture is to be operative in the evaluation of their own findings and the findings of others. The norm of communism prescribes that science is necessarily an open and public process. Accordingly, secrecy of findings is detrimental to the scientific process and is an obvious violation of this norm. Finally, the norm of disinterestedness defines acceptable sources of motivation for the scientist in the search for new knowledge. Appropriate motivations include curiosity, peer recognition, and the satisfaction of good work. Inappropriate motivations are those leading to "personal advantage," e.g., fame and money. As has been posited, conformity to these norms of the scientific ethos is facilitated by the existence of those conditions of science defined by the assumptions of purity, autonomy, and impartiality. Conversely, the likelihood of nonconformity is enhanced by the existence of conditions at variance with these assumptions — condi-

tions which the findings of the previous section indicated prevail for many contemporary scientists.

(1) *Universalism*

The moral norm of universalism directs scientists to practice their profession without consideration for their personal values, their acquaintances, or the particularistic qualities of their peers and colleagues. In short, they are expected to bracket their beliefs, values, commitments, and prejudices. The one exception, of course, is their belief in and commitment to science itself. The response patterns for disciplines vis-a-vis universalism are another instance of the patterns for the assumptions. Thus, physicists perceive adherence to universalism most, biologists perceive this moderately, and sociologists perceive this least (See Table 4) Physicists, in the greatest proportion, are found in the high support

Table 4. Perception of Adherence to the Scientific Norm of Universalism by Discipline

Degree of Perceived Support	Discipline		
	Physics	Biology	Sociology
High	43.9%	39.2%	18.2%
Moderate	38.3	31.3	35.5
Low	17.3	29.5	46.3
	100.0	100.0	100.0
N	(139)	(166)	(214)

F=19.054 significance at the .001 level

category (43.9%) and in the smallest proportion are found in the low support category (17.3%). In contrast, sociologists are found predominantly in the low and moderate support categories (46.3% and 35.5%, respectively). Very few are in the high support category (18.2%).

As usual, the responses of biologists form an intermediate pattern. A sizeable number, 39.2%, are in the high support category. The remaining biologists are almost evenly divided between the moderate and low support categories, 31.3% and 29.5%, respectively. Biologists' perceptions of universalism are more similar to those of physicists than of sociologists, a pattern which reappears for the norms of organized skepticism and disinterestedness. The views of sociologists thus diverge significantly from those of physicists and biologists and represent a perspective of scientific reality at great variance from the scientific ethos. These findings for universalism are significant at the .001 level.

The data suggest quite definitively that perceptions of adherence to the norm of universalism is far from unanimous among scientists regardless of discipline. A considerable proportion of all scientists perceive only moderate to low support. The hypothesized pattern of perception of greatest adherence among physicists, moderate adherence among biologists, and least adherence among sociologists is again found. While age, sex, ethnicity, class and political views may be somewhat influential, far more important are personal values in all stages of the scientific process — problem selection, data gathering, data analysis, and applica-

tion of findings. Finally, a scientist's chances of having his/her work accepted and published is thought to be affected by personal contacts, i.e., "whom you know." These findings indicate that for many scientists in a variety of situations orientations of particularism, nonrationality, and personal commitment tend to prevail rather than the universalism, rationality, and emotional neutrality of the scientific ethos. Just as these scientists held perspectives of the scientific assumptions different from that of the ethos, here, too, they give evidence of perspectives of the internal operations of science at variance with that contained in the classical ethos.

(2) *Organized Skepticism*

The norm of organized skepticism requires that scientists continue to hold in check their personal values as well as their belief in and commitment to particular hypotheses or theories. The responses of scientists to items in the universalism index pertaining to the perceived role of personal values in the scientific process raised serious questions about the possibility of adherence to organized skepticism. Are scientists able to remain sufficiently detached to be critical of their own work as well as the work of others? Or, do they go beyond their data in drawing conclusion? Do they maintain "faith" in hypotheses and pet theories which are not supported by the available data? Do they "go public" with very tentative conclusions?

Not surprisingly, perceptions of overall adherence to organized skepticism is not particularly high and differences among disciplines, as indicated by a significance level of .029, are not as substantial as for universalism and the assumptions of the ethos. (See Table 5)

Table 5. Perceived Adherence to the Scientific Norm of Organized Skepticism, by Discipline

Degree of Perceived Support	Discipline		
	Physics	Biology	Sociology
High	31.7%	31.3%	20.6%
Moderate	31.7	26.5	22.0
Low	<u>36.6</u>	<u>42.2</u>	<u>57.4</u>
	100.0	100.0	100.0
N	(139)	(166)	(214)

F=3.553 significance at the .029 level

Again, physicists perceive relatively greater support for organized skepticism, with 31.7% in the high support category and 31.7% in the moderate support category. Even among physicists, the largest proportion of respondents are in the low support category. Biologists are quite similar in their responses, with 31.3% perceiving high support for organized skepticism and 26.5% perceiving moderate support. A still larger proportion of biologists, 42.2% perceive only low adherence to this norm. Sociologists, in typical fashion, fall predominantly in the low support category, indicating both a relatively and absolutely low level of perceived adherence to this norm. Compared to 57.3% in the low support category,

only 20.6% of sociologists give high support and 22.0% offer moderate support.

As these findings reveal, the differences among disciplines in the perception of adherence to the norm of organized skepticism are not as great as for other norms and assumptions. Moreover, the largest proportion of scientists of each discipline is in the low support category for this particular norm of the scientific ethos. All scientists are obviously skeptical about the prevalence of skepticism among their colleagues. The only difference among them is that sociologists are most skeptical, physicists are least skeptical, and biologists are in the middle. The majority of responses of all scientists clearly indicates perceptions of lack of support for the Mertonian ethos vis-a-vis organized skepticism. Apparently, many scientists are guided by more than "solely the data" in deriving conclusions and going public with their findings.

(3) *Communism*

Communism is the norm governing behaviors, i.e., making open and public the scientific process and scientific knowledge, which are perhaps the most vulnerable to external interference. The commonly acknowledged examples of violations of this norm are the classification or secrecy of scientific information of military, security, industrial, or medical value. There are, however, factors internal to the scientific process and ethos itself which generate secrecy rather than openness in the scientific enterprise. For example, it has been argued that competition for priority in discovery (to achieve, of course, peer recognition and satisfaction and certainly not fame or money) leads to secrecy rather than the sharing of one's research with one's "competitive" colleagues.

As might have been expected, we find that perceptions of adherence to the norm of communism are not especially supportive of the scientific ethos. The largest proportion of the total sample agreeing with any of the statements measuring this norm is 55.2%. What emerges as most noteworthy, however, is the striking lack of difference in response patterns among the three disciplines for only this norm among the four norms and three assumptions of the scientific ethos. The nonsignificance, statistically speaking, of these differences is attested to by a significance level of .999. (See Table 6) Thus, in the high support category are found 33.8% of physicists, 36.8% of biologists, and 32.7% of sociologists. Moderate support is offered by 38.1% of physicists, and 31.9% of biologists, and 31.3

Table 6. Perception of Adherence to the Scientific Norm of Communism, by Discipline

Degree of Perceived Support	Discipline		
	Physics	Biology	Sociology
High	33.8%	36.8%	32.7%
Moderate	38.1	31.9	31.3
Low	<u>28.1</u>	<u>31.3</u>	<u>36.0</u>
	100.0	100.0	100.0
N	(139)	(166)	(214)

F=.205 significance at the .999 level

% of sociologists. Low support comes from 28.1% of physicists, 31.3% of biologists, and 36.0% of sociologists. These figures lead to the inescapable conclusion that the responses and perceptions of scientists of all disciplines are extraordinarily similar.

Substantively, this lack of statistical significance of differences among responses of physicists, biologists, and sociologists and the failure of the data to support the hypothesized differences is significant and in need of explanation. Such an explanation is available, I believe, when the empirical indicators at hand are combined with logic and intuition.

In the literature there is acknowledgement of the classification or nonpublic nature of some scientific knowledge — most often resulting from security considerations — though other considerations are occasionally cited. The act of preventing scientific information from entering the scientific community and the public domain is itself a fairly overt act which can be consensually validated by scientists regardless of personal values, particularistic variables, or the paradigmatic status of one's discipline. Further, communism, more than any other norm, addresses itself to the interface between science and society more than to internal interaction among colleagues within their scientific communities. Accordingly, it seems likely that the behavior it governs is more susceptible to the constraining impact of limited purity, autonomy, and impartiality in science.

In other words, perceptions of adherence to communism may be less affected by the degree of development or consensibility of disciplinary paradigms than by the material conditions of funding and institutional setting (e.g., governmental, military, industrial) which impose external "nonscientific" restraints upon the behavior of scientists. These restraints would be particularly obvious with regard to decisions affecting the public or private status of "sensitive" scientific data. Finally, the fact that physicists and biologists are employed in greater numbers than sociologists in these nonacademic settings and receive higher levels of funding from a variety of sources means that they will have more exposure to these realities of the material conditions of scientific activity. This more extensive exposure of physicists and biologists may have a "compensatory" effect and thus reduce these scientists' level of support to the lower level of support generally found among sociologists. The net effect is that there is virtually no difference in perceptions of communism among scientists of all three disciplines.

It is clearly evident that even scientists in the academy are substantially affected, at least in their perspectives of "scientific reality," by the restraints upon the norm of communism experienced by scientists dealing with a variety of types of information and people. Communism is perceived as most compromised by information of military or security value and of industrial value, as well as by the need to withhold information from scientific knowledge is acknowledged to be widespread. The absence of substantial differences among disciplines vis-a-vis perceptions of the norm of communism results in a failure of the data to provide support for the hypothesis of differential perspectives of the scientific ethos. In an attempt to explain these findings, it was suggested that scientists' perspectives of communism may be more a product of the material conditions of scientific activity vis-a-vis external institutions and scientific competition than a product of the degree of para-

digm development among disciplines. Finally, an analysis of individual items revealed that many scientists of all disciplines believe violations of communism to be prevalent in science today. In this respect, the findings for the norm of communism are much like the findings for the other norms and assumptions, i.e., scientists generally provide a low level of support for the classical Mertonian scientific ethos.

(4) *Disinterestedness*

The scientific norm of disinterestedness prescribes the acceptable, i.e., selfless and communally-oriented, sources of motivation for individual scientists. These include “curiosity and the desire for discovery,” “peer recognition,” and “the satisfaction of work well done.” In contrast, “monetary reward” and “fame,” both essentially leading to personal gain and advantage, are construed as inappropriate motivating factors.

Response patterns of perceptions of the norm of disinterestedness again offer support for the hypothesis of differential perspective of the scientific ethos among scientists of the three disciplines (See Table 7). These findings of differences among disciplines are significant at the .009 level.

Table 7. Perception of Adherence to the Scientific Norm of Disinterestedness, by Discipline

Degree of Perceived Support	Discipline		
	Physics	Biology	Sociology
High	42.5%	41.0%	27.6%
Moderate	18.7	17.5	14.0
Low	38.8	41.5	58.4
	100.0	100.0	100.0
N	(139)	(166)	(214)

F=4.778 significance at the .009 level

Typically, the largest proportion of physicists (42.5%) are in the high support category and the largest proportion of sociologists (58.4%) are in the low support category. What is perhaps noteworthy, however, is that a substantial number of physicists (38.8%) also fall in the low support category. Biologists, in almost equal numbers, are in the high (41.0%) and low (41.5%) support categories. Thus over 40% of both physicists and biologists give high support to disinterestedness, while only 27.6% of sociologists do so. On the other hand, a sizable proportion of all scientists (38.8% of physicists 41.5% of biologists, and 58.4% of sociologists) offer only low support for the norm of disinterestedness.

These data for the norm of disinterestedness support the hypothesis of differential perspectives of the scientific ethos by discipline, with physicists demonstrating perceptions of greatest support for the ethos, biologists perceiving moderate support, and sociologists perceiving least support. More specifically, it appears that contemporary scientists are motivated for the “right”—selfless and communal—as well as the “wrong”—selfish and personal—

reasons. Physicists, biologists, and sociologists almost unanimously agree that scientists are motivated by curiosity, peer recognition, and work satisfaction. The vast majority of these scientists also agree that scientists are motivated to pursue personal gain through monetary reward and fame. The norm of disinterestedness is, therefore, perceived as partially supported and partially rejected.

Summary

We find substantial differential perspectives of the moral norms of universalism, organized skepticism, and disinterestedness posited in the Mertonian — classical scientific ethos among scientists of different disciplines. These differences are in the directions hypothesized and at significance levels of .029 or better. Physicists, whose experience is within the context of a high paradigm science, perceive greatest adherence to these traditional norms. Sociologists, experiencing the conditions of a low-paradigm science, perceive least support.

Biologists, operating from the perspective of a moderate paradigm science, perceive moderate support for these norms — their support is somewhat less than that of physicists but often considerably more than that of sociologists. Only for the norm of communism are the responses of all scientists almost identical and the hypothesis of differential perspective by discipline not supported. In this instance it was argued that the reality of external constraints and of internal competition are more powerful than the paradigm development of disciplines in influencing scientists' perceptions of adherence to communism versus privacy and secrecy of scientific information.

The analysis of individual items provides the data necessary to describe in more detail scientists' perceptions of the scientific enterprise today. They indicate that personal values and contacts play an important role in the scientific process while particularistic criteria such as sex, class, ethnicity, and political ideology are less important. They assert that scientists often draw conclusions and go public with their findings even when the data are not conclusive. They believe that scientific information is often kept private and secret, especially if it is of military or industrial value or if it might be useful to competitors. They identify as sources of motivation for individual scientists not only curiosity, peer recognition, and work satisfaction, but also monetary reward and fame. In short, scientists exhibited substantial disagreement that the conditions and behaviors prescribed by the scientific norms prevail among scientists today.

V. Conclusions

The data presented provide support for the hypothesis of differential perspectives of the assumptions and moral norms of the classical— Mertonian— ethos of science among physicists, biologists, and sociologists. In developing this hypothesis it was posited that the impact of discipline upon perceptions of science operates through differences in "consensibility" or degree of paradigm development among disciplines. Accordingly, for six of the seven assumptions and norms we find, as anticipated, that the largest proportion of physicists,

whose discipline is highest in "consensibility" and paradigm development, perceive the "reality" of science to be most consistent with the traditional ethos. In contrast, the largest proportion of sociologists, whose discipline is low in "consensibility" and paradigm development, perceive little consistency. In essence, sociologists' perceptions are at odds with the traditional scientific ethos. Biologists, whose discipline exhibits moderate "consensibility" and paradigm development — still closer to physics than sociology — provide intermediate levels of corroboration for this ethos. Not surprisingly, then, the specific response patterns of biologists more closely resemble those of physicists for autonomy, impartiality, universalism, organized skepticism, communism, and disinterestedness. A greater similarity between the responses of biologists and sociologists is found only for the assumption of purity. Perhaps this is so because of the long established and accepted contribution of biological research to the practice of medicine. Only for the norm of communism is the level of support by scientists of all disciplines virtually identical. As argued previously, this may be due to a greater impact of the conditions of science — external constraints on openness and internal competition — than of paradigm development upon perceptions of adherence to this scientific norm.

With the exception of communism, the differences among disciplines are statistically significant at the .029 level or better. The actual levels of significance for the assumptions and moral norms are as follows: for purity, .024; for autonomy, .001; for impartiality, .006; for universalism, .001; for organized skepticism, .029; for communism, .999; and for disinterestedness, .009. Thus, the most statistically significant differences are found for the data on autonomy and universalism; differences for impartiality and disinterestedness are close behind. Differences for purity and organized skepticism are considerably less significant; and those for communism are nonexistent.

Apparently paradigm development and "consensibility" have their greatest effect upon perceptions of internal neutrality (autonomy) and the absence of particularistic factors in the scientific process (universalism) as well as upon the freedom of science from extraneous interferences. This effect is somewhat less for impartiality and disinterestedness. Scientists' perspective of external neutrality, i.e., what scientists do in non-scientist roles and the nature of scientists' responsibility for and/or appropriate courses of action vis-a-vis the consequences of scientific research (impartiality), appear to be slightly more independent of the influence of paradigm development. This same observation can be made regarding scientists' perceptions of the sources of individual scientists' motivations (disinterestedness).

Paradigm development and "consensibility" seem to have still less influence on perceptions of purity and organized skepticism. This reduced influence for purity may be explained, at least in part, by the greater employment and funding of physicists and biologists by nonacademic societal institutions. These conditions of employment and funding may thus result in a view of science as "less pure" than the high degree of paradigm development of these disciplines alone would dictate. The findings for organized skepticism suggest that the gap between data and conclusions, theory, etc., may be far greater for all disciplines, regardless of "consensibility" and paradigm development, than the traditional

ideal model of science would indicate.

These findings relate only to comparative or relative differences in degree of support for the traditional scientific ethos. The examination of responses to individual items allowed us to discover more specific information and a more direct measure of "absolute" support for the scientific assumptions and moral norms via "agree" and "disagree" responses. The pattern of greater agreement among physicists, least agreement among sociologists, and intermediate responses among biologists recurred for the myriad items constituting the indices for the assumptions and norms. Moreover, substantial disagreement with the traditional scientific ethos was found to exist among all scientists.

The data call into serious question the perceived validity of the traditional assumptions of science. Thus, the assumption of scientific purity is not highly supported. For three of the five items measuring purity, more than half of the total sample reject this assumption. In contrast, over 50% agree with the traditional ethos for the two remaining items. General agreement is low, as well, for the assumption of scientific autonomy. On four to twelve items comprising the autonomy index over three-fourths of all scientists disagree that autonomous conditions prevail; and 60% or more disagree for another five measures. In only two instances do over 50% agree with the assumption of autonomy. A similar low level of support is found for the assumption of scientific impartiality. On two of the three items measuring impartiality, over half of the scientists reject this assumption, and slightly more than 50% accept it for the third measure.

The scientists in this survey widely perceive the behavior of scientists and the conditions of science to be at variance, also, with the moral norms of the traditional scientific ethos. In assessing universalism, more than 50% of all scientists disagree that it prevails on three of six measure, and more than 80% disagree on two additional items. For only one measure do over 50% perceive adherence to universalism. Moreover, on all four of the items comprising the organized skepticism index, 60% or more of the scientists indicate their awareness of violations of this norm. In judging conformity to the norm of communism, 50% or more of all scientists see violations for four of the eight measures. Over one-third disagree with communism on two more items; while a third or more agree that this norm is adhered to for three of the eight items. Similarly, evaluations of the norm of disinterestedness are split. Over 70% of the scientists reject the operation of this norm for two of five measures; but 95% or more support disinterestedness on the remaining three measures.

It seems appropriate, then, to attempt to develop a set of counter-assumptions and counter-norms vis-a-vis those of the traditional ethos and to thereby paint a more complete and accurate picture of the institution of science in contemporary American society. The following formulation of a "counter-ethos" is derived from the data though, in some instances, it may go beyond the data, involving conjecture and speculation. It should be noted that the data of this study and the "counter-ethos" presented below are consistent with and supportive of Mitroff's (1974) earlier postulation of counter-norms in science. The present study is different, however, in that it goes beyond the research of Mitroff and others in its systematic exploration of perspectives of the scientific ethos among scientists

in three disciplines. Most importantly, the conceptualization of a counter-ethos of science rests on a firm and specific data base and subsumes a consideration of both the necessary and prior assumptions of science and the operating moral norms of this institution.

Scientific Assumption: Purity

Scientific Counter-assumption: Purposiveness, Goal-orientation

Scientists perceive the existence of pure science by acknowledging that one goal of science is the pursuit of knowledge as end in itself. However, basic or pure science is not thought to be more valid or legitimate than applied science. Thus, scientists also view science as the pursuit of knowledge to be used by government, military, industry, etc. and/or to improve the condition of minorities, oppressed peoples, and the environment.

Scientific Assumption: Autonomy

Scientific Counter-assumption: Connectedness, Circumscription of freedom

Scientific autonomy is found to be circumscribed by internal limitations of discipline, paradigms, training and, most importantly, by decisions made in funding agencies regarding what research shall be supported. Ties of science to governmental, military, and corporate institutions also compromise scientific autonomy.

Scientific Assumption: Impartiality

Scientific Counter-assumption: Partiality, Responsibility, Action

Impartiality is not perceived to be maintained by scientists in their roles as citizen, layperson, etc. It also appears that judgments are made concerning desirable or undesirable consequences and, that scientific information is sometimes withheld. There is thus some movement toward evaluation, responsibility, and action.

Norm: Universalism (Neutrality, Rationality)

Counter-norm: Particularism (Commitment, Nonrationality)

The scientific process — including problem selection, data gathering, analysis and interpretation, and utilization of findings — is found to be very much influenced by the personal values of the scientist, particularly in the first and least instances. Also, the acceptance and publication of scientific ideas is thought to be affected by the scientist's "personal contacts." Variables such as sex, ethnicity, class, and political ideology are not viewed *per se* as being crucial for the operation of the scientific process.

Norm: Organized skepticism

Counter-norm: Organized dogmatism

Scientists, it is indicated, derive conclusions from their data even when the findings are not conclusive. Further, they make such information available to others in the form of hypotheses, data, and inputs which may have practical applications (e.g., medicine and social policy).

Norm: Communism

Counter-norm: Privacy, Secrecy

Substantial infringement upon the public nature of scientific knowledge is found to exist,

particularly for information of military or security value and of industrial value, or for individuals who are scientific competitors.

Norm: Disinterestedness

Counter-norm: Self-interestedness

Scientists are thought to be motivated not only by selfless reasons operating in the communal interest-curiosity and the desire for discovery, work satisfaction, peer recognition-but also by selfish reasons contributing to personal gain-money and fame.

It is evident from the foregoing discussion and analysis of the data and the formulation of a counter-ethos that American academic scientists today hold perspectives of the assumptions and moral norms of science which differ considerably, in many instances, from the traditional ethos of science. These scientists perceive themselves, their colleagues, and the institution of science as being not only "in" society, but "of" society, i.e., as woven into the fabric of society. On an institutional and an individual level influences and effects are received and transmitted. Scientists are portrayed as very human, as possessing and acting on their personal values and commitments. They even, on occasion, act out of self-interest. They may also evaluate the consequences of their research findings and withhold them if negative consequences are anticipated. Many believe that they cannot or, at least, do not escape the boundaries of discipline, paradigms, and training. Scientists recognize that the institution of science has been altered by its external relations. In terms of purpose, funding, and control of scientific information societal institutions — especially governmental, military, and corporate ones — have left their mark on the scientific institution. The scientific process is more goal-directed, more controlled through funding, and more secret.

The powerful explanatory value of scientific discipline, mediated through differential "consensibility" and paradigm development of scientific fields, has been demonstrated. For six of the seven assumptions and the norms of the scientific ethos significant differences were found among the perspectives held by physicists(high-paradigm scientist), biologists (moderate paradigm scientists), and sociologists (low-paradigm scientists), providing substantial support for the hypotheses of the study. Physicists, of course, offered relatively greater support for the traditional ethos, biologists gave moderate support, and sociologists indicated very minimal support for the traditional ethos. Additionally, it has been noted, the general level of agreement of all scientists with the traditional ethos is low. Some scientists of all disciplines were found in all categories — high, moderate, and low support and agree, disagree, and no opinion. Even academic physicists and biologists, among whom we would expect to find greatest support for the traditional ethos, give only partial and limited support to this ethos.

Two related conclusions and one question emerge as inescapable at this juncture. The first conclusion is that the contemporary institution of science is not monolithic — structurally, paradigmatically, or morally. Science is located within a variety of institutional structures, the most obvious being academic, corporate, and governmental. Scientific fields are defined and carved out in terms of differences in paradigms which include definitions of subject matter, theories, methodologies, problems, and techniques; fields differ with respect to

consensibility or degree of paradigm development; and paradigms within a field may change over time (through scientific revolutions).

Finally, and most importantly, science as a "moral" system, i.e., as a system of assumptions and norms forming an ethos — is also variable. The concept of "scientific ethos" or the moral system of science may be further specified as a system of assumptions and norms embodying an image of the scientist as social actor and social agent in the internal and external systems of scientific activity. The traditional ethos has been outlined in much of the literature. In contrast, a counter-ethos has been formulated from the data and presented here to supplement earlier, fragmentary postulations of counter-norms. This counter-ethos assumes that science is purposive, connected, and circumscribed. The scientist, as social agent, is, therefore, partial, committed, responsible, and action-oriented. The scientist, as a social being, often acts on the basis of personal values, personal contacts, commitment to pet hypotheses and theories, and self-interest. The scientist is aware that scientific information may be kept secret and private for competitive and security reasons.

It should be definitively and unambiguously noted that scientific paradigms and scientific ethos are distinct and separate phenomena. Paradigms are specific to scientific fields and concern themselves essentially with the conceptual and research tools necessary for the operation of the internal system of science. The scientific ethos, on the other hand, is often generalized to scientists of more than one discipline, and defines the scientist as a social actor and agent in the internal and external systems of science. The scientific ethos, through assumptions and norms, defines the relations between science and society, and specifies appropriate modes and orientations of action for the scientist in interaction with colleagues (internal system) and with institutions, individuals, and constituencies in the larger society (external system).

The second conclusion addresses itself to the hypothesized and empirical relationship between scientific paradigm and scientific ethos when scientific structural locus (in this case, the academy) is held constant. The data substantially support the hypothesis that among academic physicists, biologists, and sociologists relative degrees of support for the traditional scientific ethos are related to relative degrees of paradigm development. High paradigm scientists (physicists) offer relatively more support for the traditional ethos and less for the counter-ethos. The reverse is found among low-paradigm scientists (sociologists); and moderate-paradigm scientists (biologists) who provide moderate support for both the traditional and the counter ethos. As observed above, scientists of all disciplines are found at all levels of support; and all scientists show less "absolute" support for the traditional ethos than for the counter-ethos.

An important question remains, as yet, unasked, and thus unanswered. How much of the variation in perspectives of the ethos of science can we attribute to or explain in terms of scientific discipline, i.e., degree of paradigm development? Are there other factors and variables beside the differential paradigmatic status of scientific fields which contribute differential perceptions of the scientific ethos? The answer to the first question is that much of the variation in perspectives of ethos is attributable to discipline. Moreover, the

specific amount of influence of discipline and paradigm development varies depending upon the assumption or moral norm in question. For example, in considering the norm of communism, it was found that discipline makes virtually no difference in scientists' perceptions. This underscores the observation made above that scientific paradigm and scientific ethos are distinct and separate phenomena. A scientist's perspective of the scientific ethos is assuredly affected by more than the paradigm development of the scientist's field.

The second question must, then, be answered in the affirmative. Other factors and variables beside scientific paradigm development are obviously affecting scientists' views of the scientific ethos. The difficult question is, of course, the third one, which asks for these factors to be identified. This question has no pat or easy answer.

Mitroff's(1974) research may be of heuristic value in attempting to formulate at least one plausible answer. Mitroff studied differences in support of counter-norms among Apollo moon scientists all of whom come from discipline generally defined as high-paradigm fields (geology, chemistry, physics, astronomy, and engineering). He found variations in outlook related to the intellectual division of labor, i.e., the specific type of activities engaged in when doing scientific research among these scientists. Mitroff's Type I scientists — the theoretical, speculative, and most creative scientists — are also the most personally committed or biased in their work, i.e., most supportive of the counter-norms. The Type III scientists are largely technicians. They are more impartial and neutral and thus supportive of the norms of science. Type II scientists are between these extremes.

Mitroff further explains the differences between Type I and III scientists and their work in terms of the "consensibility" of their activity. That is, are they dealing with ill-defined problems or well-defined ones. Theoretical, speculative scientists work primarily with ill-defined problems, while data gatherers work with those that are well-defined. These conditions of scientific work, he argues, may be instrumental in the particular moral view of science formed by these different scientists.

If Mitroff is correct, then the underlying premises of the examination of degree of paradigm development and of the examination of degree of "consensibility" or "ease of definition" of specific tasks within the scientific division of labor, as these phenomena relate to support for the scientific ethos, appear mutually supportive. In both instances, the key variable is the degree of clarity, consensus, and structure, whether of the paradigm of a scientific field or of the problem to be investigated. To be sure, paradigm differentiation tends to be a between discipline variable, and ease of definition tends to be a within discipline variable, and interdisciplinary problems may be evaluated in terms of one or both variables, whichever seems most appropriate. Yet, the essential dimension of degree of structure and consensibility underlies both and may be the crucial variable. One final point seems worthy of mention. Another potential factor affecting scientists' perspectives of the ethos of science is the nature of their actual work conditions — with the exception of considerations of paradigm and problem-definition. Here, too, it appears plausible to develop a continuum of degree of clarity and specificity of structure in relation to work locus and

its demands, controls, and requirements. Further research is needed to unravel and reveal the relations among scientific ethos, paradigm development, problem-definition, and work structure.

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