Introduction

For the past five hundred years in the West, the pursuit of science has been more or less unfettered. If, in the light of more recent assessments of the freedom of thought and inquiry that existed in the universities of the twelfth and thirteenth centuries, we add another three hundred years, then we may say that the pursuit of science in the West has been carried on undiminished for nearly nine hundred years. This flight of the imagination, if you will, was both sponsored by and motivated by the idea that the natural world is a rational and ordered universe and that man is a rational creature who is able to understand and accurately describe that universe. Whether or not men and women can solve the riddles of existence, so this view goes, they are able to advance human understanding mightily by applying reason and the instruments of rationality to the world we inhabit.

The breakthrough that allowed freedom of scientific inquiry is undoubtedly one of the most powerful intellectual (and social) revolutions in the history of humankind. As the paradigmatic form of free inquiry, science has been given a roving commission to set all the domains of thought aright. Science is thus the natural enemy of all vested interests – social, political, and religious – including those of the scientific establishment itself. For the scientific mind refuses to let things stand as they are. The organized skepticism of the scientific ethos is ever present and always doubtful of the latest (and even the long-standing) intellectual consensus.

Given this intellectual commission to investigate all forms and manner of existence, science is especially the natural enemy of authoritarian regimes. Indeed, such regimes can exist only if they repress or otherwise subvert those forms of scientific inquiry that reveal the true nature of the social – economic, political, and medical – consequences of their rule. We must be careful here not to confuse journalism and the press with science. The free press is

unquestionably an indispensable institution for maintaining democracy, but we should not confuse press reports, or even investigative journalism, with science. Moreover, it is clear that journalists look to science and scientists for guidance in their inquiries. In the final analysis, good investigative journalism must meet the tests of scientific inquiry, which in the social realm demands adequacy of sampling, appropriate instruments of data gathering, and sound techniques of inference and analysis as understood by the prevailing standards of social science. In the natural realm, likewise, the so-called canons of science must be observed, and the function of the press generally is to explain the findings of science to laymen, not to undertake scientific inquiry per se. Only in rare and dramatic cases do journalists undertake to determine whether a particular set of research findings was produced according to acceptable scientific standards. And in such cases, we should note, the task is the affirmation of the canons of science by pointing out their possible breach.

Can we now say that men and women in all civilizations have equally shared (or do share) the view that science is and ought to be free to state its views on all matters of inquiry? Can we say that the other civilizations of the world equally held a fully rationalist conception of the orderliness of the cosmos and equally valued the rational capacities of man to the extent that they institutionalized the means by which men could fully apply their reason in the interests of advancing the most consistent and theoretically powerful explanatory systems? The fact that modern science arose only in the West – even though Arabic-Islamic science was more advanced up until the twelfth and thirteenth centuries – suggests a negative answer to those questions.

Should the world be thought to be fully rational, understandable, and explainable by mere mortals? If we answer in the affirmative, should we continue to support and extend the neutral zones of free inquiry even further so that researchers may continue to develop their scientific systems of thought in all domains, which will raise ethical issues and quite possibly bring some harm (through misuse as well as continuing scientific ignorance) but a great deal of human benefit? And if we go that far, how shall we design such institutions for the future? What are the sociological foundations – the philosophical, metaphysical, and institutional assumptions – that enable us to carry on this enterprise of freely pursuing inquiry wherever it leads? Can they be put in place in all civilizations without seriously unbalancing those societies and civilizations, and disturbing the vested interests? Or is modern science just a Western "disease"?

As we enter the global world as never before, these are surely questions of fundamental importance. To create a truly global order there must be a set of fundamental shared principles – legal, philosophic, humanitarian – which enable us to communicate freely and resolve conflicts peacefully. Perhaps

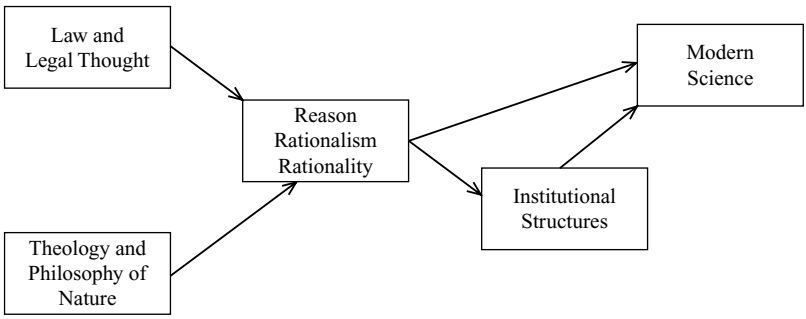

Figure 1. The domains of social process.

the conditions that allowed the development of modern science can tell us something about how societies (and civilizations) can and should be ordered so that men and women are fully enabled to participate in the construction and design of their social orders. We have much to learn about such questions, and the study of the sociological foundations of modern science may have much to tell us about the ingredients that go into the making of the "open society," freedom of expression, and the peaceful resolution of conflict.

To understand the evolution of modern science, we must consider several different levels of social and cultural process. These may be conceptualized as in Figure 1. The relationships between the domains shown in this diagram are far more complex and interactive than I have indicated, with various interactions and feedback loops between domains.

I have given law priority of place in this scheme because law (sacred law) has been the penultimate directive structure of classical Arabic-Islamic civilization. Law has been equally important in the West, but the coloring of the legal domain there has been so different (and progressive) that law seems less important than in Arabic-Islamic civilization. Ultimately, as we shall see, revolutions in the structure of Western law have been of overwhelming importance in shaping Western social, political, and intellectual experience. In the case of China, legal concepts and codes, so it is said, have played a much smaller role. Nevertheless, it is imperative to understand the role of law in China as well.

In the present context, I have been particularly struck by the manner in which legal thought has structured conceptions of rational deliberation as well as action. Legal thought in both Islam and the West has established canons of rational inquiry and placed limits on the forms of legitimate inquiry. Moreover, legal systems create the operative canons of rationality for settling disputes that arise within their domain. Viewed from another perspective, legal systems

institutionalize a whole range of social and cultural forms by mandating the forms of human relationships and the means for dispute resolution. Accordingly, the study of legal systems becomes a useful window through which we may grasp the underlying structural properties of a society and civilization. Both the forms of rationality and the institutional apparatus created by the legal system are of paramount interest.

Because scientists take it as their mission to explore and define the elementary structures and processes of nature, it is equally important to consider the images of order, chaos, and process that appear in systems of religious and theological thought. It is obvious to the modern reader that the traditional images of man, nature, and the universe ensconced in religious thought have been profoundly shaken by the rise of modern science. It has not been widely appreciated, on the other hand, that some religious and theological systems have contained images of order, regularity, and even system-processes that have been conducive to the development of science. Theological systems have shaped conceptions of reason and rationality as attributes of man and nature. These metaphysical presuppositions have been particularly fertile for encouraging scientific thought. The absence of theology in a strict sense in China is a matter of some importance, both for the history of thought in China and for contemporary understandings of that civilization.

As we shall see, indigenous systems of legal thought, as well as religious and theological ones, function to create images of man's rational capacities as well as images of the rationality of nature. From the point of view of the evolution of modern science and intellectual life, these early intellectual systems have been of paramount significance. It is true also, of course, that one must recognize the independent influence of philosophical systems of thought, which, due to the Greek tradition in the West, have been of very great significance for the development of modern science. In short, a study of the sociological foundations of modern science takes one into the metaphysical and philosophical foundations of science, and this takes one further into the anthropology of man and the philosophy of nature.

Finally, a major factor in this developmental perspective that must be scrutinized is the nature of the institutional structures which are the repositories and intellectual laboratories within which conceptions of reason and rationality are set to work. Sociologists have not attended enough to the deep structures of social institutions and the ways in which they are products of the legal concepts within which the institutions are situated. Once social institutions are embodied in a normative order, and particularly under the aegis of the legal formalisms of the day, a new level of social and cultural process is put into effect. Such institutions may function in a conservative fashion, giving the society and culture a perdurable cast; or the social institutions may embody

progressive and even revolutionary thematics and thus, over the course of time, may function to powerfully reshape and transform the social, political, and economic orders. Such is what transpired in the West, and we are well advised to understand the dynamic nature of those *institutional* arrangements. The study of the rise of modern science from this point of view is the study of *institution building*. From the perspective of late modernity it may be the paradigmatic story of the creation of modern social institutions.

In Chapter 1, I attempt to locate the present study in the literature of the comparative and historical sociology of science. Aside from a monumental study by Joseph Needham and the seminal responses to that work by the late Benjamin Nelson, little has been done to establish a framework within which comparative studies can be fruitfully undertaken between the scientific enterprises of the East and the West. Joseph Ben-David's inquiry into the role of the scientist provides a useful point of departure, but his complete omission of any discussion of either Arabic or Chinese science necessarily creates a tunnel vision that prevents one's grasping the import of the religious, legal, and philosophical contexts within which science must always be carried on. In Chapter 2, I set out the problem of Arabic science, and in Chapter 3, I analyze the differing philosophies of man and nature found in Arabic-Islamic civilization and the West. In Chapters 4 and 5, I attempt to elucidate the philosophical and legal foundations of institution building in the two civilizations, especially their contrasting implications for universities and madrasas. Chapter 5 also contains additional material on developments in medicine in the Muslim world and the West during the period of our interest.

In Chapter 6, I summarize the major elements of the great social and intellectual transformation of the West in the twelfth and thirteenth centuries as they bear on questions of the *ethos of science*. I have done so with a view to spelling out the cultural and institutional impediments that prevented the emergence of modern science and its ethos in the Arabic-Islamic world. In Chapters 7 and 8, I extend the framework of analysis to the case of China. The new Epilogue attempts to provide an overview of educational reforms and attitudes toward science since the eighteenth century, especially in the Muslim world.

In Chapter 9, I extend the discussion to the sixteenth- and seventeenth-century scientific revolution in Europe. There I highlight the triple revolution that occurred in cosmology, scientific method, and religious authority. The great intellectual struggles that went into the fashioning of the institutional foundations of modern science are the very ones that have shaped the structures of modernity more generally. Accordingly, readers familiar with the writings of Max Weber will be aware that the problem of the rise of modern science is exactly parallel to the problem of the rise of capitalism in the

West – and only there. Throughout this undertaking I have been aware of this parallelism and Weber's suggestion that exploring this question was "the next step."[1] I agree with this suggestion and with the judgment of Benjamin Nelson and Joseph Needham that this problem of the unique rise of modern science in the West is more fundamental for sociological inquiry than the rise of capitalism. I record these thoughts here only to alert the reader to the fact that this has been uppermost in my thinking about the problem at hand, but that I deliberately chose not to burden the reader with constant references to Weber's far-ranging thoughts on all these questions, for that would entail another volume altogether.[2]

I must add one last comment which I hope will prevent the mistaken interpretation that I have overly identified reason and rationality with modern science. As I have tried to make plain, the European medievals had a great faith in reason that gave birth to a variety of new forms of rational discourse. Before the rise of modern science, there was the science of faith (theology) and the science of law (jurisprudence). As any reader knows who has read Max Weber's introduction to his *Collected Essays on the Sociology of Religion*, which was inserted as the Author's Introduction to the English translation of *The Protestant Ethic and the Spirit of Capitalism*, the West is distinguished from the Middle East and Asia not just in the successful birthing of modern science, but in its rationalizing pursuit of all forms of thought and action, art and music included. Indeed, Weber's 1911 essay, *The Rational and Social Foundations of Music*, is a brilliant reminder of the fact that in the West music too was subjected to all the rationalizing impulses of the Western spirit, with the result that contrapuntal polyphonic music, the full development of equal temperament in music, and the symphonic orchestra are all unique Western creations. It is to this work of Weber's that one should look, therefore, in attempting to formulate the meaning of the idea of rationality and the processes of rationalization. Beyond that we must remember that modern science is but one domain in which we should look for the embodiment of rationality. When Joseph Needham suggests that the rise of modern science is some kind of package deal, he ought to insist, therefore, not on the linkage between science and capitalism, but on the linkage between the rise of a great faith in reason and the application of this real or imaginary agency to the study of the natural world and to all the other domains of cultural existence.

[1] Max Weber, *The Protestant Ethic and the Spirit of Capitalism* (New York: Scribner, 1958), p. 182.

[2] The reader can consult a recent assessment of Max Weber's writings on Islam by contemporary Islamic scholars in Toby E. Huff and Wolfgang Schluchter, eds., *Max Weber and Islam* (New Brunswick, N.J.: Transaction Books, 1999).

As we envision the world of the future and ask whether or not there will be a "pacific renaissance," the central issues are the same: will the developing countries of the world allow their citizens full participation in the realms of the mind – scientific, political, and literary – or will they continue to erect barriers to freedom of thought, expression, and action in the interests of primordial religious and ethnic identities? One can say only that significant portions of Asia, especially Southeast Asia, appear poised to go forward. At the same time, there are many forces arrayed against such openings. The struggle to achieve this global awakening is being waged, but it is somewhat premature to speak of the postmodern era: the conditions of modernity have yet to be achieved among the greater part of the peoples of the world.

1

The comparative study of science

The modernity of science

In the present world, science and its offshoots appear to be the epitome of modernity. The scientific method of treating every conceivable natural, human, or social malady is everywhere in evidence. If the scientific approach has not been applied to the problem at hand, the treatment and analysis are thought to be either defective or suspect. This state of affairs is not bereft of moral critics who think that science itself has too much power or that the strictly scientific point of view, especially in medicine, claims too much, is overly confident, arrogant, and even capable of reaching false diagnoses. In the Western world there are those who think that science itself is a "social problem."[1] To them the technological products of science – excessive levels of radiation released into the atmosphere of local communities, the inadequately monitored use of pesticides, the general degradation of the natural environment caused by the dumping of toxic substances, and even global warming – are all to be laid at the door of modern science and technology. Nevertheless, alternative forms of knowledge – those derived from religion, mysticism, or occult sciences such as astrology – must offer their own defenses against the prevailing scientific posture. If they are to be accredited, these alternatives must be shown to produce their results and achieve their effects in ways that are consistent with either scientific ignorance ("about this we have no knowledge") or scientific wisdom ("this outcome is perfectly conceivable within expanded parameters of our present scientific knowledge").[2]

[1] Sal Restivo, "Modern Science as a Social Problem," *Social Problems* 35 (1988): 206–25.
[2] For discussions of the growing dominance of the scientific worldview, see the essays in *The Knowledge Society: Its Growing Impact on Scientific Knowledge*, ed. Gernot Böhme et al. (Dordrecht: Reidel, 1986).

Indeed, it is common to refer to the privileged status of scientific knowledge in the modern world. This phrase means several things. First, it implies that the knowledge claims of scientific experts are given pride of place in public discussion and, above all, in matters of health, public and private. Second, expert witnesses, who are reputed to be scientific experts, are permitted to testify in courts of law regarding arcane and abstruse topics that laymen are hard-pressed to understand. In such circumstances these experts are permitted to use their scientific knowledge to establish possible facts as well as the probable causes of events. Readers of mystery novels know of forensic experts who, through laboratory techniques, match fragmentary samples of fibers or hair to clothing and possible suspects and thereby link individuals to the scene of a crime. Such scientific knowledge is not based on firsthand observation of the events but is after-the-fact knowledge gleaned through the techniques of scientific analysis and inference. In short, the very idea of scientific knowledge has dramatically altered what is considered legitimate evidence and testimony in courts of law.[3]

Third, we may speak of scientific research as privileged in the sense that the legitimating authority of science grants permission to researchers to observe and even publicly describe those areas of life that are generally hidden from public view out of a sense of privacy or that are ruled off-limits by moral or religious scruples. For example, physicians are permitted to physically examine disrobed bodies in the most intimate of fashions. This is done in the name of science. Similarly, social scientists as well as press reporters are often permitted to gain inside information on all aspects of public and private life. For sociologists, political scientists, and social anthropologists, the justification of such unrestricted observation is based on the desire to advance social scientific knowledge about how the social and political worlds work. Thus, a sociologist studying the police of a local community will attempt to observe every aspect of the daily routine of police officers. The researcher will not only observe the apprehension and arrest of suspects but also listen in on phone conversations (as a surrogate detective) received by the vice squad from potential informants at police headquarters. This also is done "in the name of science."[4] But there is another level of privilege that should be noted. This is the privilege granted to researchers to gather evidence and information unhindered and to possess this information free from seizure by political authorities. This is the limited protection granted social scientists and journalists to freely gather and dispose

[3] See, for example, Hans Zeisel, "Statistics as Legal Evidence," *International Encyclopedia of Statistics*, vol. 2 (New York: Macmillan, 1978), pp. 1118–22.
[4] See Jerome Skolnick's defense of all these practices in *Justice Without Trial*, 2d ed. (New York: Wiley, 1976), chap. 2.

of information as they see fit without any obligation to publish it or reveal its sources to political authorities. Likewise, they are free to criticize the social order or segments of it based on their inquiries. But the privilege I would like to emphasize is that which is granted by the courts of law and which establishes the inviolability of the researcher's right to withhold knowledge from public scrutiny.[5] These, then, are some of the ways in which we may speak of the privileged status of scientific knowledge and inquiry in the Western world. They help to give substance to the view that the institutions of science are among the most important in modern society.[6]

While we in the West take the scientific point of view as the standard by which all others are to be judged, it often escapes our attention that the scientific point of view (which I shall deliberately leave undefined for the present) had to fight its way to success through many long battles. Beyond that, modern science, as we know it, failed to materialize in other civilizations of the world (in India, China, and Islam), despite the fact that some of them had great cultural and scientific advantages over the West up until the thirteenth and fourteenth centuries. That realization ought to encourage us to consider the possibility that the arrival of modern science at its destination in the West was in fact the outcome of a unique combination of cultural and institutional factors that are, in essence, nonscientific. In other words, the riddle of the success of modern science in the West – and its failure in non-Western civilizations – is to be solved by studying the nonscientific domains of culture, that is, law, religion, philosophy, theology, and the like. From such a point of view, the rise of modern science is the result of the development

[5] I refer here to the case of a sociology graduate student in the early 1980s, Mr. Mario Brajuha at the State University of New York, Stony Brook, who was engaged in a field study of a restaurant on Long Island that subsequently burned down. The circumstances surrounding the fire suggested to police investigators that arson was a strong possibility. Upon discovering that a graduate student had been studying this establishment and recording extensive research notes, an attorney in the case attempted to subpoena the sociologist's notes in the hope that they might contain clues regarding the fire. After a prolonged court battle, including testimony from a variety of social scientists regarding the importance of protecting such research from undue interference, the court ruled that the sociologist's notes were in fact protected from unreasonable seizure and that it was not in the interest of society at large to coerce the revelation of the research notes because of the chilling effect such an action would have on future research, which the court believed enriches our knowledge of how social systems operate. See American Sociological Association, *Footnotes*, Aug. (1984), p. 11, and the *New York Times*, Apr. 5–6, 1984.

[6] The view that science is the most significant modern institution has been suggested, albeit with agnostic affirmation, by Harriet Zuckerman, "The Sociology of Science," in *The Handbook of Sociology*, ed. Neil J. Smelser (Beverly Hills, Calif.: Sage, 1988), pp. 511–74. On p. 511 Zuckerman also cites Derek J. de Solla Price, who put the claim more boldly: "It [science] has transformed the life and destinies of more of the world's peoples than any . . . religious and political event," above all, by controlling economic and military forces as well as the quality of life of the peoples of the world.