bined with a succession crisis and other problems), the rest of Europe could have suffered a fate like that of Russia, and without a possible "window to the West" to redeem it from cultural and economic backwardness after getting laid waste during an invasion. Also, other reasons for the West's rise should not be discounted, such as the sociological-political organization issues Alan K. Smith points out,[3] which involved how certain western nations, particularly Britain, had their governments taken over by the productive classes away from parasitic kings and aristocrats, which made sustained economic growth possible. Nor should the West's collapse into barbarism after the Roman Empire's breakup, which made the West a cultural backwater for nearly a millenium, be overlooked. China, India, and the Islamic world were economically and culturally superior to the West for most of the period 500-1450 A.D. Hence, the intrinsic advantages the West's intellectual climate had over other traditions[4] could not have necessarily prevented an earlier military extinction, exclude other reasons for the West's rise, or deny that other civilizations had obvious cultural superiority over the West that lasted for centuries.

The West benefited culturally from the fortuitious combination of two intellectual traditions that allowed for the birth of modern, self-sustaining science: The classical Greek tradition, as best exemplified by Aristotle's Organon,[5] and Christian theology, with its vision of a personal, transcendent, moral God, which were both combined in a synthesis by St. Thomas Aquinas in his Summa Theologica, and by other Christian theologians. Combined with the arrival of positional Hindu-Arabic numerals from the East, which added the "indispensible"[6] element of easily-performed, precise quantification, these two traditions combined made the birth of modern science possible.

Saying ancient Greece's science and logic was absolutely necessary for the rise of science is not an especially controversial statement, for despite their many errors, it gave mankind paradigms for investigating nature that were falsifiable, instead of givng vague generalizations that are hard to test.

The Greek respect for reason and emphasis on rationality was an enormously important reason for the West's subsequent rise in later centuries. The Greek emphasis on reason was imparted to Christianity (although it had some of this already), and this emphasis on reason still suffuses Western culture, even with many an assault by various assorted sophisticated skeptics. As it has been pointed out, truth emerges more quickly from error than confusion, which is why the classical paradigm had its value. However--to attribute science's rise even indirectly to Christianity will raise many a titter at its seeming self-evident absurdity. After all, does not the Inquisition's showdown with Galileo, and the fundamentalists' assaults against evolution, prove science and religion are forever irreconcilable?

What we need to do, first, is take a deep breath, and take a step out of today's overwhelmingly secularized intellectual climate, and consider this: Modern science arose among the avowedly Christian clerics, theologians, monks, and professors of medieval and renaissance Catholic universities and monasteries. If Christianity and science are totally incompatible, how did this occur? After all, neither Galileo nor Copernicus were skeptics or unbelievers, unlike their medieval predecessors Omar Khayyam or Frederick II, Holy Roman Emperor.[7]

At this point we need to introduce what I shall call the Duhem-Jaki[8] and Merton theses. These two theses are quite different in how they tie Christianity to the birth of science. Duhem and Jaki, respectively past and present professors of Roman Catholicism, see a direct tie between Christian metaphysics, its rejections of various classical Greek philosophical conceptions, and the birth of a self-sustaining science. On the other hand, Robert K. Merton, the sociologist who wrote Science in Seventeenth Century England[9], ties seventeenth century English Puritanism's ethics to the rise of English science, much the same way Max Weber tied the rise of capitalism to Calvinism.[10] It should be stressed Merton sees the rise of English science only as a relatively inadvertent product of Puritanism's values and beliefs, using an externalist approach,

while Duhem and Jaki take a more internalist approach by looking at the intellectual roots of science and by seeing theology and science as closely tied together in the medieval era since the same people often did both (like the Frenchman Nicole Oresme).[11] Merton only sees Protestantism as helping science along, and not as creating it, for Galileo and his predecessors were Catholics.[12] Somewhat peculiarly, despite their obvious differences, these two theses often seem to pass each other like two ships in the night without partisans or critics of one mentioning the other.[13]

Nor should we assume technological advance proves a given culture has science, or modern science, for most inventions that affected daily life in the pre-modern period economically were "empirical" discoveries by craftsmen, not true scientists. While the Greeks, Chinese, Indians, and Islam all had what can be fairly called "science," their science lacked the rigor that would characterize the West's science from Galileo onwards, and soon fizzled out on their own. "Science" shall be defined as follows for my purposes: The systematized collection of knowledge about nature through the use of reason and sense experience only in order to discover the underlying laws of nature, which explain how nature is organized and allow future accurate predictions about nature's processes or objects to be made. Only Greek geometry fully meets this definition, along with mathematics in general, prior to the time of Galileo.

First, let us begin to describe the tenets of the Duhem-Jaki thesis. It denies that sociological non-intellectual, externalist causes are sufficient conditions to create modern science:

> "This historiography of science has still to face up honestly to the problem of why three great ancient cultures (China, India, and Egypt) display independently of one another, a similar pattern vis-a-vis science. The pattern is the stillbirth of science in each of them in spite of the availability of talents, social organization, and

peace--the standard explanatory devices furnished by all-knowing sociologies of science on which that historiography relies ever more heavily."[14]

All of these conditions may be necessary to allow a civilization to develop science, but we have to look to the intellectual climate to understand why only one particular civilization developed a self-sustaining, modern science. Peculiarly, this same culture had been in the immediately preceding centuries intellectually and economically quite backward compared to the great Eurasian cultures that rivaled it. Abu-Lughod and others influenced by Marxism are often loathe to investigate how the intellectual climate can independently change on its own, and can influence politics and economics. For we should realize while the mode of production can and does infleunce the superstructure of ideology as Marx maintained, the reverse influence can and has happened also. Although this assumption will not be proven here, I shall maintain "ideas have consequences" throughout this paper.[15]

So now--according to Duhem and Jaki, what ideas are necessary to have (or, to be more precise generally, not have) in the intellectual climate of a civilization to keep science self-sustaining, instead of fizzling out after a few centuries of progress? First, a linear, potentially quantifiable conception of time that clearly distinguishes past, present, and future promotes a scientific view of nature and its cause-effect relationships. The alternative view of time, the concept of the "Great Year," maintains centuries-long time cycles exist in which the future repeats the past exactly or almost exactly, making progress of any kind impossible, hinders the possibility of science in a given culture. Second, if science is to exist, explanations of natural phenomena must avoid a priori, pseudo-scientific "explanations" that really do not describe the causes of events. Astrology is a prime

example of this idea. Third, science is hindered by the organismic view of nature: All of nature is seen as alive, as if it was one huge organism, which goes through the above mentioned cyclical process from birth, to maturity, then death, to be born again. This view sees what we moderns consider inanimate objects, like rocks, the planets, the stars, the oceans, and other natural objects to have wills of their own, or intelligences of their own. Fourth, science is hindered if the reality or the basic orderliness of the universe ("the external real world") is denied, for humans will not often investigate carefully what is considered not to exist, or that which will be changed at whim by God(s), or nature herself. Fifth, the heavens (outer space) must not be considered alive, or divine, if a scientific astronomy is to exist. Sixth, a balance between reason and faith is necessary, without the religious people totally rejecting science or natural laws, and without the philosophers/scientists totally rejecting the claims of religious truth. So long as all or most of these false ideas are believed by a great majority of the intellectuals of a culture, a self-sustaining, modern science will not come to exist in a given civilization, especially any true science of bodies moving in the external real world i.e. physics.

Now, the tie between the acceptance or non-acceptance of such ideas and science may not be altogether obvious.[16] Hence, a lot of explanation (and the balance of this paper) is used to show the connection. Also, it should be noted that some civilizations had all or most of these false ideas, such as Hindu India, while other(s) had fewer of them (China), and other(s) still fewer (Islam). Correspondingly, the latter progressed in science further as compared to the former correspondingly to the acceptance of such ideas. For instance, the Chinese lacked the delusion the heavens were divine and/or living,[17] which was a Greek conception found in Aristotle's On the Heavens, which hindered indigenous Islamic science[18] permanently, and Christian

science for many centuries before being finally cast off. On the other hand, Hindu science concerning the outside real world was crushed by almost all these faulty intellectual ideas: the eternal real world and its orderliness were denied, eternal cycles and the organismic view of nature were espoused, and the heavens were seen as divine. Islamic science would have become self-sustaining, if the Quran had not emphasized God's will and power so much as against His reason, and if Muslim philosphers and scientists had not become so mesmerized by Aristotle's physics and philosophy. Let us consider each of these great rival civilizations to Christendom in turn, and see how these faulty metaphysical concepts held their science back.

When we look at the great civilization of China, and its marvelous wealth, population, and technological inventions during the ancient and medieval periods, it is easy to wonder why science did not occur there first.[19] Paper, gunpowder, the compass, and moveable type were all Chinese inventions. China's sophisticated rice agriculture, improved by selective plant breeding, was much more productive than contemporaneous medieval European agriculture.[20] Yet, it must be noted such technological developments do not prove China had modern science:

> Nevertheless the accompanying assumption of Singer (who influenced Joseph Needham, the great Sinologist of Chinese science and technology) and of his era (the early twentieth century) that engineering innovation has almost always sprung from prior scientific discovery is not warranted by the facts. This has certainly confused Needham about China's influence upon European science, and I suspect that it has not clarified his probings of the Chinese phenomena."[21]

This distinction Abu-Lughod apparently has missed,[22] which is why it was not mere time and chance China declined whilst the West rose, riding the back of the first modern science.

Let us note some of the science-hindering metaphysical concepts as found in Chinese philosophy and religion. The concept of eternal cycles

was most certainly present. One Buddhist monk attacked the Christian dogma of creation as follows:

"'Space, worlds, and beings have no beginning nor end if we consider them not in themselves and individuals but in their totality. They are eternal from this global point of view. They profliferate without end and during incalculable cosmic periods progress through successive stages of formation, stability, degradation and then a return to nothingness.'"[23]

Such views were no mere individual eccentricity of this monk, but were throughout Chinese intellectual life, having apparently been strengthened by the entrance of Buddhism, and were assimilated into Neo-Confucian thought.[24] The problems caused by acceptance of such cycles of thousands of years in which the world and its civilizations are repeatedly created and destroyed only to be created again is that it creates a sense of metaphysically-induced hopelessness and passivity since no matter how hard humans may struggle to achieve, work and think, the results of all efforts will be destroyed. Also, a non-linear view of time makes careful, precise quantification of time irrelevant, and makes people tend to confuse the order of cause and effect since the idea of this-after-that (succession) is weakened. Yet science requires non-passive investigators of nature, precise quantification of time, and the knowledge of causes. Jaki illustrates the consequences of this view with

the fact that the Chinese saw nothing inordinate in attributing the political failure of a certain prince to the sacrificing of humans at his burial. As both political impotence and cruelty evidence the absence of the same virtue, one could replace the other as explanation regardless of their sequence.[25]

Jaki goes on to quote Granet's comment that cause and effects did not matter to the Chinese, but manifestations whose order did not matter since being "Equally expressive, they appeared interchangeable."[26] With the Chinese having

such a conception of time, a true modern science would never have spontaneously arise among them--or any other civilization believing in eternal cycles so firmly.

Another metaphysical delusion the Chinese sadly suffered from (though they were hardly alone) were various a priori pseudo-scientific explanations of natural events. The two best examples of this in Chinese thought were the two forces of Yin and Yang on the one hand, and the book of Changes (I Ching) on the other. Yin (female) and Yang (male) were seen as the two forces pervading all of nature and its processes. As a result, the Chinese would not hesitate to assign "the changes of weather to the stillness of Yin."[27] Yin and Yang were used to explain why magnets became attracted to each other, and describe the sun, moon, and stars' movements.[28] Likewise, the I Ching was a manual of of divination that would line up various sayings and interpretations of natural events through various sysmbols such as lines, trigrams, and hexagrams. Through this book any observation in nature ("omen") would be given an instant interpretation as to its cause and significance. Although normally very sympathetic to the claims of Chinese culture and sience, Needham still was willing to say: "Yet really they (Han dynasty scholars) would have been wiser to tie a millstone about the neck of the I Ching and cast it into the sea."[29] The most widespread of pseudo-scientific delusions was astrology, which plagued Islam, Indian, even Christendom to a great degree--and China as well.[30] At the Emperor's court, various "wise men" (astrologers, astronomers, and meteorologists) would interpret and blame on the emperor various portents.[31] For having such a priori "explanations" of natural events dulls the human mind through thinking it knows why such events occur, when in fact the laws of nature are still unknown. To posit such metaphysical entities as Yin and Yang, or the effects of the stars upon people's destinies, and then say they determine natural processes creates the delusion of knowledge out of ignorance. Of course, the Chinese were hardly alone in having such delusions--see Aristotle's On the Heavens, and his four elements theory, for starters.

Another metaphysical conception that hindered Chinese science was an organismic view of nature, which sees all of nature as one huge living creature that goes through a cycle of birth, maturity, and death. Here Taoism, which conceived of nature as "an all-encompassing living entity animated by impersonal volitions," was a source of trouble for Chinese science.[32] True, Needham, sympathetic as always, strongly emphasizes how the Taoists would contemplate nature and believed it had an underlying order (Tao can be best translated "order of nature" Needham believes).[33] However, the Taoists would not actively investigate nature as opposed to a mystically-inclined contemplation and inactivity concerning it: "He who practices the Tao, daily diminishes his doing. He diminishes it and again diminishes it, till he arrives at doing nothing. Having arrives at this non-inaction, there is nothing that he does not do."[34] This attitude of non-activity (not intended to be taken literally, as even Jaki commented),[35] is at least partly due to how Taoism would see mankind as totally weak and impotent compared to the majesty of nature, with which he should seek an intimate organic unity.[36] For by seeing nature as a vast, single spontaneously acting organism (albeit as mystically inspiring as that may be for many), it kept them from developing the idea of natural law in the modern sense. Needham himself, although noting the tie in Chinese thought between the cyclical and organismic concepts, failed to realize the negative consequences of such concepts by trying to put them in the most positive light.[37] However, such is the result of such a concept, as Jaki describes:

> The organismic concept of the world (not in the Whiteheadian sense) invariably fosters a state of mind dominated by a nostalgic longing for the primitive golden age, with its idyllic settings in which everything takes place in an effortless way. In that dreamlike condition of spontaneousness men live off nature without disturbing it, and carry out their social propensities without the sense of constrain due to authorities and laws."[38]

In short, both belief in eternal time cycles and in nature as one huge

organism encourage the passivity that opposes the mentally active, investigating spirit of science.[39]

The Chinese would believe nature both was orderly and had an actual existence (when not influenced by the rather pervasive, Hindu-derived Buddhist ideas of maya, the belief that all is illusion). However, they lacked the concept of natural law, as ordained by a personal God, which made nature rationally understandable to mankind:

> It was not that there was no order in Nature for the Chinese, but rather that it was not an order ordained by a rational personal being, and hence there was no conviction that rational personal beings would be able to spell out in their lesser earthly languages the divine code of laws which he had decreed aforetime."[40]

For a man who was a Marxist (and, admittedly, simultaneously, a very liberal Protestant),[41] this must have been a very hard concession to make, as Jaki pointed out,[42] for it points to an ideological cause for why modern science did not appear in China, not an economic or political one. In contrast, the view of how Christianity was tied to the rise of science in the West is best stated by the English philosopher Alfred North Whitehead (1861-1947):

> I do not think, however, that I have even yet brought out the greated contribution of medievalism to the formation of the scientific movement. I mean the inexpugnable belief that every detailed occurrence can be correlated with its antecedents in a perfectly definite manner, exemplifying general principles. . . . When we compare this tone of thought in Europe with the attitude of other civilisations when left to themselves, there seems but one source for its origin. It must come from the medieval insistence on the rationality of God, conceived as with the personal energy of Jehovah and with the rationality of a Greek philosopher. Every detail was supervised and ordered: the search into nature

could only result in the vindication of the faith in rationality."[43] Since Whitehead was at some level a pantheist, he would not be likely to concede much very willingly to medieval Christianity about its sense of the rationality of nature.

Moving westwards to the land of India, an equally perplexing problem with the lack of modern science seems to present itself. Hindu civilization on the subcontinent was ancient, well-settled, and extremely rich materially by the standards of the time. Indian routinely ran surplus balances of trade with the West, as China did. As late as 1770, the British wool industry tried to prohibit the import of Bengal calicoes into the United Kingdom.[44] And eternal credit should be given to the Hindu mind for the momentous invention of the Hindu-Arabic numerals, with their place notation and the concept of zero, which should never failed to be stressed. For without this system of enumeration, the (easy) quantification of natural events and substances, so necessary to the development of modern science, would never have occurred.

Unfortunately, Hindu civilization as a whole was weighted down with almost the most anti-scientific metaphysics imaginable. The Hindu concept of maya, the view that sense data tell only of illusion, not a real external world, was anti-scientific in the extreme. Generally, you do not systematically investigate that which you think is a mirage. Hence--the Hindu mind turned inwards, and progresses in math by leaps and bounds, but fails utterly to come up with a science of the external real world, like physics. The concept of eternal cycles, with its view of universal destruction and recreation, saturated Indian culture as well. The sense of hopelessness and passivity caused by this latter concept is aptly illustrated by the comment of king Brithadratha in the Maitri Upanishad as he contemplates an endless series of the transmigrations of the soul: "In the cycle of existence I am like a frog in a waterless well."[45] Or, consider what the god Vishnu told the god

Indra in the Brhamavaivarta Purana: "I have known the dreadful dissolution of the universe. I have seen all perish, again and again, at the end of every cycle. At that terrible time, every single atom dissolves into the primal, pure water of eternity whence originally all arose."[46] Our modern minds, which presumably automatically reject such concepts, may see their deadening effects on constructive activity by how some today react to the fear of nuclear war: "let us eat, and drink for tomorrow we die" (I Cor. 15:32). Worse yet, death is not much of an escape, for that will bring only another rather meaningless life by a rebirth, unless you have reached the final necessary stage of perfection before being absorbed into Brahma.

Hindu pantheism caused problems in developing a scientific astronomy, for the heavens were seen as divine and animate. Here the organismic view of the cosmos extracts its high price, for then the heavens are seen as alive with a will of their own, instead of being merely inanimate, inorganic matter. Eventually, in the West, Aristotle's view of the heavens being divine and/or intelligent was extinguished, but only after many centuries of the Christian era:

> . . . (D)uring the twelfth century in Latin Europe, those aspects of Judeo-Christian thought which emphasized the idea of creation out of nothing and the distance between God and the world, in certain contexts and with certain men, had the effect of eliminating all semi-divine entities from the realm of nature. Thus nature tended to become a mechanistic entity, running according to the characteristics with which it had been endowed and powered by the forces it had been given in the beginning.[47]

Left to itself, Hindu pantheism would never have eventually eliminated the divine, organismic view of nature since it saw no ultimate difference between God and the universe.

The most widespread pseudo-science in Eurasia was (and is) astrology, and to this day India is plagued with its influence. By tying a person's destiny to an arbitrary interpretation of what the stars and planets' given positions are on some day is a denial of the scientific outlook. It encourages a passive, fatalistic attitude in individuals through the complete denial of free will. Why both to know the try to change the world, when your destiny has been decreed by the heavens? Even today, India is saturated by this nonsense, and far more people take the predictions made far more seriously than occurs in the West. "Call for such conversion will hardly be heeded as long as the voice of astrologers is not on the wane but on the rise (in spite of science and education) and carefully listened to by high government (Indian) officials."[48] Although astrology attained a grip upon much of the Islamic and Christian worlds, and even in modern, twentieth century America it has its devotees (like Nancy Reagan), but the culture of Christendom had built-in limits to its broad cultural acceptance since it is seen as an idolatrous system that also denies moral responsibility. Hence even as astrology grew in the West with the recovery of the Greek classics and the growth of interest in science,[49] the Church continued to condemn it.[50] Unfortunately, India had nothing in its culture that frontally assaulted astrology--hence the former remains deeply in the latter's thrall to this very day.

Now the failure of the Islamic world to produce modern science is much more curious than India's or even China's failure. The flourishing of Islamic science and scholarship under the Umayyads and early Abbasids with their use of the Greek classics was simply remarkable. The medicalworks of al-Razi and Avicenna were used by Christendom deep into the sixteenth century, more than 500 years after their deaths. The fact such English words as astrolabe, chemistry, alcohol, algebra, algorism, and azimuth are derived from Arabic shows the influence Islamic science had on the West. Islamic mathematicians made immense contributions such as al-Khwarizimi (the algorism and algebra), Thabit ibin Quarra (studied irra-

tional numbers), Albategnius and Abu al-Wafa (trigmonetry), Umar Khayyam (works on analytical geometry), and Nasir al-Din al-Tusi (trigonometry).[51] Furthermore, believing in a single God who created the universe at a definite point in time, with time linearly proceeding to judgment day, Muslims were not obvious, easy prey for eternal cycles, the organismic view of the universe, or astrology. Orthodox Muslims did not deny the reality of the external world, nor were apt to think the heavens were divine/alive since they emphasized the monotheistic nature of God so strongly. So why did Islamic science mostly fizzle out after 1200?

Unfortunately, for the Islamic world, its leading philosophical, theological, and scientific figures made some very serious wrong turns. The key problem was a lack of balance between faith and reason: no Islamic equivalent of St. Thomas Aquinas showed up to systemically reconcile and integrate the theology of Islam with the rationalism of the Greek classics. Hence, the two most important orthodox Islamic theologians, al-Ashari (873-935) and al-Ghazzali (1058-1111) were very mystically inclined, and both stressed God's will as opposed to His reason. Al-Ghazzali's work, Incoherence of the Philosophers, sharply assaulted the Aristotlian philsophers called the mutazilites, and maintained the doctrine of occasionalism, which sees the law of cause and effect as only occurring due to God's continual intervention in the universe. Hence, if a rock lands on my big toe after I release it, the resulting pain is only due to God putting it there in me, not due to the properties of the rock and toe themselves. The direct consequences of such a concept against the idea of scientific law of nature can easily be imagined.[52]

On the other hand, the Islamic philosopher Avicenna (980-1037) and Averroes (1126-1198) clearly subordinated their Islamic faith to Aristotle's metaphysics. Indeed, Averroes' concept of double truth--of saying what was true for religion was not necessarily true for philosophy--denies the metaphysical unity of the intellectual and sensible world, and allows him to avoid having to deny Aristotle's On the Heavens when it conflicts with the

Islamic faith.[53] These two philosophers, much like the mutazilites, fell completely under the spell of the ancient Greek classics (or nearly did so), and could not conceive how these classics could be wrong. They did not try to reconcile Islam and the Greek classics as so much as ignore the conflict. Here they fell into the trap of accepting easily gained a priori concepts about the physical world. A true science of physics could not develop until Aristotle's On the Heavens and Physics were junked, and that only occurred in the West due to the tenets of Christian theology conflicting with these two works, and individual Christian philosophers and theologians pointing out such conflicts without ignoring them. Unfortunately, this process of partial rejection and partial acceptance in an overall synthesis did not occur in the Islamic world, for Avicenna and Averroes seemed to think Aristotle could think no wrong, and al-Ghazzali and al-Asharai seemed to think Aristotle could think nothing right (I am exaggerating, but not that much).

In addition, and rather strangely considering the tenets of orthodox Islam definitely conflict with such concepts, the Islamic world had a wide acceptance of eternal cycles, astrology,[54] and the organismic view of nature as reflected in the belief the heavens were alive, or even divine. For instance, al-Kindi vehemently attacked alchemy, but promoted the ideas of eternal cycles along with ibn-Khaldun, the famous north African Islamic historian. Both tried to fit historical events into 20 and 240 year time cycles. Abu-Mashar, in his Book of the Revolution of Birth Years, said the Deluge would recur every 180,000 years. The Brethren of Purity's encyclopedia that summarized knowledge (Rasa'il) was saturated with astrology, the occult, and containe even the view that 3000 time year cycles corresponded the rise and fall of civilizations as determined by the Zodiac. Avicenna did not see God as directly creating mankind, but as the emnation of a series of higher intelligences, each of which grew weaker, until the final, weakest one made mankind.

Astrology ran surprisingly rampant, due to the influence of the Persians and Hindus the Muslims had conquered, as well as the Greek classics. Even such a critic of eternal cycles as al-Birundi still wrote a book espousing astrology.[55] The end result of these concepts running amuck without the equivalent of the 1277 condemnation by Bishop Tiempier against pagan (or other such condemnations or cultural acts of resistance) Greek concepts that plainly conflicted with Islam helped to strangle Islamic science.

However, Islamic failure in science has a deeper root: The way Muhammad in the Quran emphasized God's will and power at the expense of God's rationality. It is common for people to think the God of the Bible is just like the God of the Quran, especially the non-religious who think, "All religions are the same." However, this assumption can be seriously questioned once the texts and accompanying history of the Bible and Quran are compared. Drawing upon a list of comparisons and contrasts made by Dr. Robert Morey, some evident differences arise. The God of the Quran is not active directly in history (since He did not enter history personally as Jesus via the Incarnation did), is totally unlimited in his possible choices (the Christian God is limited by his essence, as illustrated by Titus 1:2, which says He cannot lie), less knowable (due to Islam's condemnation of applying positive predications to God; humanity's knowledge of God consists really only of negatively stated attributes), and less personal (since Allah is seen as so transcendent men cannot know him personally).[56] In particular, when considering the impact of the Quaran's theology on science, the following comment by Morey is sobering:

"6. Because the God of the Bible is limited by his own righteous nature and there are certain things He cannot do, he is completely consistent and truthworthy. But when we turn to study the actions of Allah in the Quran, we discovered that he is totally capricious and untruthworthy. He is not bound by his nature or his word."[57]

Hence, when al-Ghazzali condemns the concept of the laws of nature as restrict-

ing God's freedom to act, he is perfectly in line with the Quran: It is not just his personal idiosyncratic interpretation of it. The consequences of such a view were well described by the Jewish scholar, Maimonides, who saw the Mutakallium (orthodoxIslamic theologians) were only willing at most to concede the laws of nature were like the customary riding habits of the caliph going through a city: subject to change at whim if desired. "(T)he thing which exists with certain constant and permanent forms, dimensions, and properties (in nature) only follows the direction of habit . . . on this foundation their whole fabric is constructed."[58] Hence, the metaphysics of the Quran helped to sink Islamic science.

In the West, pagan beliefs in eternal cycles, the organismic view of nature, belief in astrology, the divinity/aliveness of the heavens and the illusionary nature of the external world ran into the hard rock of Christian theology. Hence, although the classical corpus (as elucidated by Muslims like Avicenna and Averroes who were not truly orthodox) strongly encouraged belief in such anti-scientific concepts in the West, there was always enought intrinsic cultural resistance in the Christian intellectual community as a whole to keep such pagan concepts from totally mesmerizing Christendom. Christianity by itself, without the Greek classics (or Hindu-Arabic numerals) would not have created modern science (most likely). However, the dogmas of Christian theology allowed a certain intellectual community to strip the classics of antiquity of these anti-scientific concepts due to their conflict with Christian theology, allowing a true modern science to eventually blossom. Of course, if Christians had not believed in such opposing concepts, such a conflict would not have occurred and science would not have reached a modern, self-sustaining form in the West. Pierre Duhem, in his Le Systeme De Monde, maintained that modern science was made possible by the Bishop of Paris Tempier's condemnation in 1277 of 219 propositions, which blasted these anti-scientific concepts of antiquity.[59]

While Jaki and Duhem commit the error of overemphasizing the contribution of Christian theology relative to the ancient Greek contribution to the rise of science, there is very much an important contribution made by the former that is normally overlooked. Imagine--the dogmas of Catholicism promoting the rise of science! We must not let Galileo's fate at the hands of the Inquisition blind us to this contribution of Christian theology in sweeping away the rubbish of these pagan beliefs from science, whcih kept science from becoming self-sustaining and modern. But notice the Christian contribution is not so much as creating a broad respect for rationality, or the discovery of the basic laws of the logic used in scientific reasoning (Aristotle's Organon). Rather, Christian theology (by chance conflict, someone could argue) shot down the false, self-inhibiting ideas of the pagan's science, absorbed much of its respect for reason from them, and then allowed science to blossom forth. I believe Christian theology removed the intrinsic inhibitions on a stunted, limited-intrinsically science, not that it created science by itself mostly from scratch.

IMPORTANT TO EMPHASIZE

The reason why eternal cycles could never be accepted by Christians is that it would involve repeating exactly or almost exactly the events of the Bible's history. And to a Christian, the thought of God dying horribly on a stake repeatedly again and again is totally unacceptable: ". . . because this He did once for all when He offered up Himself" (Heb. 7:27). Hence, even when some Christians influenced by pagan thought accepted the idea of eternal cycles, which include Origen[60] and even St. Thomas Aquinas,[61] the concept was accepted in a highly mitigated form that that greatly lessened its ill effects.[62] Origen and St. Thomas both still believed in an absolute starting point (creation), ending point (judgment), and that free will still existed, which mean the passivity and sense of hopelessness induced by the treadmill of meaningless alterations of catastrophes and golden ages in history was largely removed. Some early Christian theologians,

such as Jerome (who translated the Vulage Bible) and Hippoclytus, condemned eternal cycles totally.[63] St. Augustine was more equivocal, but was willing to forcefully condemn the more literal forms of eternal cycles, still believed in creation and judgment, and denied reincarnation, which allowed him to maintain a basically linear conception of time.[64] The condemnation of eternal cycles in proposition 92, and of the eternal existence of the universe (a belief necessarily tied to the former) in propositions 83-91 helped to put a limit on the acceptance of these doctrines, and helped to keep many philosophers/theologaians in Christendom from totally capitaulating to Aristotlian thought, as had happened with Islamic culture with Avicenna and Averroes and the Mutazilites.[65] Oresme, a direct forerunner of Galileo in developing physics freed from Aristotlian conceptions, condemned such cycles.[66] Hence, the Christian belief in creation and judgment kept Christendom off "the treadmill of the Yugas" (Jaki's phrase), killing a sense of passivity caused by hopelessness, and promoting a linear conception of time that made the precise quantification of time and cause-effect relations to be more easily conceived.

Astrology, that prime example of an answering-giving a priori pseudo-science, ran into repeated condemnations by Church Fathers and theologians. St. Augustine, as noted above, blasted it in the Confessions. Hippolytus hit it hard in The Refutations of All Heresies.[67] While the early medieval Church fought astrology very successfully, the increasing interest in science due to the recovery of the Greek classics, made interest in astrology surge as well.[68] A condemnation of astrology figured in proposition 105 of Tempier's list.[69] Oresme told the king of France, his patron in a booklet to ignore astrology.[70] Isadore of Spain in the early medieval Church attacked it also.[71] While Roger Bacon agreed with astrology to some degree, he still rejected its control over individuals' destinies as opposed to that of nations.[72] However, as even Bacon's case shows, there were limits to the acceptance of this system that allowed science to eventually develop independently of interest in astrology.

The divinity of the heavens, which is normally closely allied to the organismic view of the natural world, was gradually eliminated by the medievals.[73] The mesmerizing power of Aristotle was felt in Europe too, however, which is why this process took so long. Jerome denied the heavens were alive, but St. Augustine remained in an anguished uncertainty.[74] St. Thomas entertained the notion, but only to a limited degree.[75] Even Kepler, the discoverer of elliptical orbits of the planets, still believed intelligences controlled the movements of the heavens.[76] But, the saving grace in all this was the limits on this idea's acceptance due to an already developed concept of natural law: "The overwhelming majority of European thinkers accepted the reality of the order of nature (unlike the Hindus), and most considered nature to be a self-sufficient creation of God, containing all the powers necessary for its operation without God's direct intervention (unlike al-Ghazzali's concept of the universe's natural laws)".[77]

For the West began to develop the idea of the universe being rationally knowable since God made it: "The cosmologists (of the twelfth century) felt certain that all of nature was fundamentally rational because the all-knowing God had made it so. . . . William of Conches writes that 'The world is an ordered aggregation of created things'. And Thierry of Chartes says: "The world would seem to have causes for its existence, and so to have come into existence in a predictable sequence of time. This existence and this order can be shown to be rational'."[78] The clockmaker metaphor for the universe was used by Oresme.[79] Bacon felt all branches of learning had basic unity, interdependence, and interconnectedness since only one God made them all.[80] With the approval St. Thomas gave to reason in Summa Theologica, science could go forward as secure in the existence of natural law, which was a concept al-Ghazzali and al-Sahari denied to Islam by emphasizing God's will and power too much.

The first key steps in totally discarding Aristotle's physics were done by Buridan and Oresme (1323(?)-1382). For Galileo and Leonardo da Vinci had

learned upon them indirectly for many of their seemingly totally new ideas in physics or in other fields.[81] While Greece had developed a science of geometry that could be called modern, its physics remained hopelessly backward by comparison since the pagan ideas about eternal cycles, the irrationality of the universe, and the divinity of the heavens, had held its physics back. Buridan, in a crucial passage, anticipated the idea of inertia through his discussion of impetus. Notice the referral to God not directly making the law of nature operate:

> Also, since the Bible does not state that appropriate intelligences move the celestrial bodies, it could be said that it does not appear necessary to posit intelligences of this kind, because it would be answered that God, when He created the world, moved each of the celestial orbs as He pleaded, and in moving them He impressed in them impetuses which moved them without His having to move them any more except by the method of general influence whereby He concurs as a co-agent in all things which take place; 'for thus on the seventh day He rested from all work . . .' And these impetuses which He impressed in the celestial bodies were not decreased nor corrupted afterwards, because there was no inclination of the celestial bodies for other movements."[82]

Also note this passage:

> But because of the resistance which results from the weight of the mill, the impetus would continually diminish until the mill ceased to turn. And perhaps, if the mill should last forever without any diminution or change, and there were no other resistance to corrupt the impetus, the mill would move forever because of its perpetual impetus."[83]

While these passages are only halting steps on a long road to repealing Aristotle's physics, they do show a move to break out of his conceptions of how moving bodies move. With the later discoveries of

Galileo, Hooke, Kepler, Torricelli, Boyle, Newton and others, Europe's science took a vast qualitative leap, but we should not overlook its origins and these men's predecessors in the Middle Ages.

Now Merton's thesis does not claim as much for Christianity as the Duhem-Jaki thesis does for the former merely sees seventeenth century Puritan ethical values as being conducive to engaging in scientific endeavors. One partial critic of Merton's thesis pointed out how some values of Puritanism opposed science even as some promoted it:

> If seventeenth-century science grew in harmony with Puritan values of utility, reason, empiricism, and the glory of God, it also grew by distancing its activities and goals from other values or sentiments displayed by Puritanism: intolerance, dogmatism, enthusiasm. [84]

Also, since Merton is a sociologist, he is approaching science through its relationship to the rest of society, which is an externalist approach, instead of looking at science from inside its own history.

Merton lists various values that helped promoted science among Puritan Englishmen in the seventeenth century.[85] One is to glorify God and serve Him through doing activities of utility to the community as a whole, as opposed to the contemplative, monastic ideal of withdrawal from the community. Through "the drive for the conviction of one's election, . . . the Calvinistic doctrine of predestination escapes any drift toward an apathetic pessimism."[86] Through emphasizing a vocation (again, something useful to the community as a whole) this created diligence, industry, and hard work in Puritans. As the Quaker leader Baxter put it: "No: no man should do so without a special necessity or call: for there are general precepts on all that are able, that we live to the benefit of others, and prefer the common good, and as we have opportunity do good to all men."[87] The result is the individual chooses the vocation which is best suited for his or her abilities). Reason and education were both praised, the latter

needing to be practical in nature, not highly literary in content, and definitely not in the philosophy of scholasticism.

The religious values and beliefs of many English scientistsof this period are easily documented. For instance, in the chemist Robert Boyle's last will and testament we find this: "Wishing (the Royal Society) a happy success in their laudable Attempts, to discover the Nature of the Works of God, and praying that they and all other Searchers into Physical Truths, may Cordinally refer their Attainments to the Glory of the Great Author of Nature, and to the Comfort of Mankind."[88] John Ray, the great biologist, told a friend that sparing time to investigate nature was a good thing to do: "What time you have to spare you will do well to spend, as you are doing, in the inquisition and contemplation of the works of God and nature."[89] Although not a Puritan himself, Francis Bacon had a Puritan mother who had influenced him, and his emphasis on the utility of scientific discoveries (as opposed to knowledge for its own sake) has a Puritan ring to it. Forty-two of the 68 founding members of the Royal Society (starting through meetings in 1645 unofficially) for which their religious background was known were Puritans, which is very much out of whack compared to their proportion in the total English population, which had a strong majority of Anglicans. Sir Robert Moray, Sir William Petty, Robert Boyle, John Wilkins, John Wallis, and Jonathan Goddard were all prominent leaders of the Royal Society--and all Puritans.[90]

Furthermore, the scientific method needs both an empiricist and rationalist approach to nature to work properly. Curiously, Puritanism provided both by having the rationalism of St. Augustine's type of Neo-Platonism, yet needing empiricism in order to properly serve on'e calling (vocation) and be useful to the community as a whole.[91] The irony to this is that Luther attacked the Copernican view of the universe, and Calvin was not enthusiastic over many of the scientific discoveries of his day. What this shows is the unintended consequences of the new religious values

of Protestantism.[92] Interestingly, even as the Counter-Reformation was damaging Catholic science (the Inquisition's effort against Galileo, for instance), Protestant science was taking off, helping to make up for the slack.[93] Although we have only briefly surveyed the Merton thesis, partly because it overlaps the Duhem-Jaki thesis and so some concepts are shared in common by both, it need not be dwelled upon more here. However, it helps to show when pious Puritan scientists discussed thinking God's thoughts after Him and trying to know God's attributes better through studying his creation (compare Romans 1:20), they were not saying this as a rationalization to justify their activities, but really meant it.

So far, this essay has been an exercise in intellectual history, and it has not shown the practical consequences of science upon economics. When does the European lead in science have much in the way of practical consequences? For the inventions that allowed the Europeans to take over the New World and sweep the Islamic world largely out of the Indian Ocean's trade in the sixteenth and seventeenth centuries were not based on European science: ironmaking, gunpowder, the tacking ability of caravels, the compass, and astrolabe. Indeed, all these inventions except possibly the caravel's tacking ability had long since been known, indeed invented in other areas of the world. A person could agree with H.F. Kearney and say: "The revolutionary discoveries in science had no practical application, anymore than Darwin's theory of Evolution had."[94] Kearney was speaking with the commercial revolution and the sixteenth and seventeenth centuries in mind in particular, but is the point more generalizable? Certainly, with all the marvelous technological gadgets that exist in most Americans' homes (the TV and telephone come to mind, though taken totally for granted normally), it is obvious scientific ideas today have consequences. But when did this start to happen in the past?

It seems in retrospect that it was during the through the late eighteenth and early nineteenth centuries during the industrial revolution, that a chasm of economic differentiation between the West and the East opened. Even as late as

concerning 1770, Gillis was willing to say: "By world standards, Europe's productive capacity in 1770 was by no means overwhelmingly superior. For centuries Asia had been far more technologically inventive than Europe."[95] Yet, beginning in the eighteenth century came the West's rise that today has left the "Third World" in the dust economically, including most of Asia.

"'From the year 1770 to 1788 a complete change had gradually been effected in the spinning of yarn. That of wool had disappeared altogether and that of linen was also nearly gone: cotton, cotton, cotton was become the the almost universal material for employment.'"[96] And this in an industry that was begging for import protection in 1770 against Indian calicoes! I shall maintain the whole process of industrialization, which extends past the time of the c. 1770-1850 period assigned normally to the industrial revolution, was when the scientific revolution (that is, science from the time of Galileo) began to have practical consequences economically.

"It is the central thesis of this book (V.V. Rostow's How It All Began) that the scientific revolution, in all its consequences, is the element in the equation of history that distinguishes early modern Europe from all previous periodsof economic expansion."[97] What Rostow is maintaining here is that what made Europe's economic expansion in the industrial revolution was totally different qualitatively from any prior place or area's economic expansion due to the scientific revolution. But how?

It seems the tie between the two was not always direct, but that through creating a "climate of opinion" in which businessmen, craftsmen-engineers, and scientists would exchange ideas with one another, new approaches to producing goods and services got implemented. For in this era there was not such a tight segregation between the scientific disciplines, the skilled craftsmen and engineers, and businessmen, and so people would have multiple roles, or be a common contact with those of other fields or occupations in their geographical locality.[98] For example, James Watt, who invented the

separate condenser for steam engines, making them much more efficient, was influenced at least indirectly by conversations with Joseph Black, the scientist whose idea of "latent heat" would be of direct value in building more efficient steam engines: "'Although Dr. Black's theory of latent heat did not suggest my improvements on the steam-engine, yet the knowledge upon various subjects which he was pleased to communicate to me, and the correct modes of reasoning, and of making experiments of which he set me the example, certainly conduced very much to facilitate the progress of my inventions.'"[99] The scientific work of Boyle and Huygens was of direct value to the invention of the earliest practical steam engines by Savery and Newcomen. Davies Gilbert's advice helped Trevithick develop the high-pressure steam engine. Water-wheels (important for the early textile mills) were improved by the practical-scientific experiments by John Smeaton, and other scientifically-minded hydraulic engineers like Fairbarn, Rennie, and Henes.[100]

The "climate of opinion" resulting from mingling these practically-minded people with scientists, and from those individuals straddling the two areas is aptly described by Musson:

> It is clear that the diffusion of such knowledge took place at all levels, ranging from the highest scientific advances down to elementary instruction in mathematics, mechanics, etc. for humble artisans and craftsmen. In the Royal Society and Society of Arts, scientifically-minded industrialists mingled with eminent philosophers; there was a similar community of interests in local societies such as the Birmingham Lunar Society, the Manchester Litary and Philosophical Society, and innumerable similar, but less famous, bodies established in provincial towns throughout the country; while ordinary millwrights, builders, weavers, etc. sometimes belonged to the smaller local clubs, foreshadowing the later mechanics' institutes.[101]

The effects of such minds interacting and bouncing ideas off each other at local, provincial, and national levels caused various people in economic

activities to rethink the old ways they had been doing things, to see if any improvements were possible. While many of such changes may have been only incremental, they still would be indirectly due to the rise of modern science. The diffusion of science in many cases may have been nothing more than a more self-reflective rationalism on the part of businessmen and engineers, which would allow for small nameless improvements here and there, accumulating great amounts of effort saved.

Notice how Ashton describes this interactive, occupationally overlapping environment: "Physicists and chemists, such as Franklin, Black, Priestley, Dalton, and Davy, were in intimate contact with the leading figures in British industry: there was much coming and going between the laboratory and workshop, and men like James Watt, Josiah Wedgwood, William Reynolds, and James Keir were at home in one as in the other. The names of engineers, ironmasters, industrial chemists, and instrument-makers on the list of Fellows of the Royal Society show how close were the relations between science and practice at this time."[102] Someone like Boyle would tell farmers that they should try chemical experiments to try to improve their land's quality.[103] In France, the like of Lavoisier ran a model farm and did agricultural experiments there, which shows he was a man looking for practical applications of his scientific work.[104] Nearly 30 provincial scientific societies exists in Britain, with the Lunar Society's linking of amateur scientists and gentlemen-manufacturers being particularly well known.[105] Thus, all sorts of cross-cutting exchanges of information and applications of it by scientists, craftsmen, engineers, or businessmen (even if only on a piecemeal basis) were taking place.

Although only an indirect, crude sign of scientific activity because many inventions were still made by empirical craftsmen, not scientists applying natural laws, the growth of patents granted in England as the eighteenth century continued on is worthy of note. From an early peak of 102 granted in 1690-99, they slipped to 56 in 1730-39, they grew to 205 in 1760-69, 294 in 1770-79,

477 in 1780-89, 647 in 1790-99, and 924 in 1800-90.[106] The rising numbers of patents as this century drew on helps indicate a growth in the number of people seeking more efficient ways to engage in economic activities, and the scientific revolution, as it affected England, stood directly or indirectly behind this growth in the number of inventions.

As the nineteenth century dawned and drew on, the consequences of scientific discoveries on industry became more obvious. The chemical industry of Germany in the nineteenth century was built largely upon the work of the Englishman Sir William Perkins.[107] However, earlier, in the eighteenth century we find one Charles MacIntosh, trained for a career in his Father's chemical business by studying under William Irvine at Glasgow University and then with Joseph Black at Edinburgh, was the inventor of the new bleaching process for the cotton industry. This process greatly speeded up the processing of cotton cloth at the bleaching stage by suspending lime (instead of potash) in the chlorine bleaching vat, preventing a crucial bottleneck from developing in the cotton industry in the 1790's.[108] Also in the late eighteenth century, we find Josiah Wedgewood, who laid the foundations for applying factory methods to the making of pottery, was an able research chemist himself. He hired Alexander Chisholm, a Scottish graduate who had been a laboratory assistant to the industrial chemist Dr. William Lewis. Thomas Telford, a famous road and bridge builder, went "chemistry mad," and read the works of Fourcroy, Black and various other chemists, to find out more about building materials.[109] Hence, the science of chemistry began to have practical economic consequences in the industrial revolution and afterwards.

Also, as the example of MacIntosh's bleaching process helps to indicate, the needs of an industry helps promote inventiveness, especially at bottleneck points. (In the textile industry, famous examples here concerned the invention of the spinning jenny and the power loom, although these inventions were not devised by any scientist). Boyle, Hooke, and many other English

scientists took an active interest in mining due to problems experienced in driving deeper and deeper shafts, causing air and flooding problems. Boyle, Hook, and Papin all worked on air pumps that would get air to miners deep down inside shafts. Newcomen, though not a scientist, was well aware of scientific research in this area. These kinds of interactions encouraged the English historian Nef to say, "'There is a clear relation between the appearance of the extremely influential British School of "natural philosophers" and the growth of the British coal industry'."[110] British scientists also worked on the problem of calculating longitude, which was of immense value to the Navy and merchant machine when finally solved.[111]

It is true that the tie between the industrial revolution and the scientific revolution is not altogether obvious, as Rostow admitted: "The scientific revolution also related, somehow, to the coming of the first industrial revolution at the end of the eighteenth century."[112] However, there is enough evidence, especially as industry and science continue to grow and mature in the nineteenth century, of an obvious tie between the two. Today the East tries to catch up with the West in a similar way to how the West learned from the East in the twelfth to fourteenth centuries: by copying its methods. Hence, Japan rapidly modernized and westerized in the late nineteenth century, knowing to deliberately choose to not do so would result in western political domination eventually. So Japan adopted western science, technology, education, even republicanism. Japan soon managed to humble the western power of Czarist Russia in the 1904-5 Russo-Japanese War, and the U.S. and Europe many decades later in a contemporary "trade war."

Hence, when we survey the above evidence of the ideological reaons for why the West rose, we should look beyond Marxist-influenced interpretations of history that see only economic reasons for why civilizations rise and fall,

or the random influence of chance events like plagues, famines, or military invasions. Herein lies the trap Abu-Lughod falls into, throwing about the Black Death to explain what economics and politics cannot. We should come to realize that Christian theology and ethics had a generally positve impact on science, and that the industrial revolution involved in part the practical implementation of science to economics. The relationship between business and science was once put by Ayn Rand this way: "The professional businessman is the field agent of the army whose lieutenant-commander-in-chief is the scientist. The businessman carries scientific discoveries from the laboratory of the inventor to the industrial plants, and transforms them into material products that fill men's physical needs . . ."[112] Finally, however, we should realize the following maxim's truth, which Abu-Lughod has ignored: "Ideas have consequences."

FOOTNOTES

[1]her emphasis, Janet L. Abu-Lughod, Before European Hegemony The World System A.D. 1250-1350 (New York: Oxford University Press, 1989), p. 12.

[2]Ibid., p. 54, 65, 66, 81, 100.

[3]Alan K. Smith, Creating a World Economy Merchant Capital, Colonialism, and World Trade 1400-1825 (Boulder, Colorado: Westview Press, 1991).

[4]This essay is premised upon a denial of cultural and epistemological relativism. While proving such fundamentally provocative views is beyond the scope of this paper, few reasoning people would maintain the past cultures of Nazi Germany, Apartheid-bound South Africa, or Soviet Russia (with its "Gulag Archipelago") were equal to America's culture morally as it is constituted today.

[5]His body of work on logic, including the Prior Analytics, and the Posterior Analytics, which identified how human reason worked to gain knowledge through reason.

[6]his emphasis, Stanley Jaki, Science and Creation From Eternal Cycles to an Oscillating Universe (New York: Science History Publications, 1974), as quoted in Thomas S. Torrance, Zygon, March 1976, p. 77.

[7]Galileo's personal piety is mentioned in Winifred Lovell Wisan, "Galileo and God's Creation," Isis, September 1986, p. 474. The tie between "natural philosophy" and the concept of God and figuring out God's ways is mentioned in: Andrew Cunningham, "Getting the Game Right: Some Plain Words on the Identity and Invention of Science," Studies in History and Philosophy of Science, Sept. 1988, p. 384.

[8]Stanley Jaki himself probably would be embarrassed by me entitling this thesis this way. He routinely and freely draws upon and repeatedly mentions in his works Pierre Duhem, and even wrote a biography about him. Pierre Duhem is the French scientist and historian of science who wrote the magisterial ten volume Le System Du Monde. I justify naming this thesis after the both of them because Jaki seems to be the main "scholarly popularizer" of Duhem's thesis in the English speaking world. It should be noted Duhem's work mentioned above almost single-handedly created scholarly interest in medieval science.

[9]Robert K. Merton, "Science in Seventeenth Century England," Osiris, 1938, p. 360-632. This is the original edition of this book.

[10]Of course, the reference here is to Max Weber, The Protestant Ethic and the Spirit of Capitalism (New York: Charles Scribner's Sons, 1958). Especially interesting for our purpose is note 145 on p. 249, where we find Puritanism's tendencies toward empiricism mentioned. Discussing Spener's work in this area, he says a consequence of Puritanism scientifically was "that just as the Christian is known by the fruits of his belief, the knowledge of God and His designs can only be attained through a knowledge of His works."

[11]See the explanation of externalist and internalist approaches in the introduction of George Basalla, ed., The Rise of Modern Science External or Internal Factors? (Lexington, Mass.: D. C. Heath and Company, 1968), p. vii-xiv.

[13]Stanley Jaki never seems to mention the Merton thesis in any of his books I am using for this essay. Likewise, such a critic of the Merton thesis as Rabb, seems to be oblivious to Duhem's thesis. Hence he writes when attacking Hill: "In the story of the rise of science, therefore, religion is a peripheral concern," and does not mention Duhem even in passing. See Theodore K. Rabb, "Religion and the Rise of Modern Science," Past and Present, July 1965, p. 126. One interesting statement I have found on this issue is this: "Merton, who made no reference to either Duhem or Wohlwill, saw a parallel lack of continuity in the attitudes of society to science." See A. Ruppert Hall, "Merton revisited or Science and Society in the Seventeenth Century," History of Science (Cambridge, England: W. Heffer & Sons, 1963), p. 12.

[12]Rabb, "Religion and the Rise," p. 122, 125.

[14]Stanley Jaki, The Savior of Science (Washington, D.C.: Regnery Gateway, 1988), p. 35.

[15]A contemporary example is how Boris Yeltsin and his group of revolutionaries have the ideology of capitalism, and seek to impose it on a socialist economy.

[16]Jaki's Science and Creation appears to be the best argued case in one volume for this subject. Of course, Duhem's Le Systeme du Monde is available for the determined reader--who knows French.

[17]Jacques Gernet, "Christian and Chinese World Views in the Seventeenth Century," Diogenes, Spring 1979, p. 105.

[18]Jaki, Science and Creation, p. 205, 208.

[19]See Abu-Lughod, Before European Hegemony, p. 322. An in-depth analysis in the form of a series of articles can be found in Hu Daojing, Li Guohao, et al., eds., Explorations in the History of Science and Technology in China (Shanghai: Shanghai Chinese Classics Publishing House, 1982).

[20]Smith, Creating a World Economy, p. 17-18.

[21]Lynn White Jr., "Review Symposia Science in China," Isis, March 1984, p. 178. Another useful critique of Needham's work is Willard J. Peterson, "'Chinese Scientific Philosophy' and Some Chinese Attitudes Towards Knowledge about the Realm of Heaven-and-Earth," Past and Present, May 1980, p. 20-30.

[22]Abu-Lughod, Before European Hegemony, p. 322.

[23]Gernet, "Christian and Chinese World Views," p. 104. See p. 100-102 for more examples.

[24]Joseph Needham, Science and Civilisation in China, Vol. 2, History of Scientific Thought (New York: Cambridge University Press, 1962), with the assistance of Wang Ling, p. 485-7, 420, 404; Jaki, Science and Creation, p. 33-35.

[25]Jaki, Science and Creation, p, 34-35.

[26]his emphasis, as quoted in Jaki, Science and Creation, p. 35.

[27]Ibid., p. 45.

[28]Ibid.

[29]Needham, Science and Civilisation, p. 311.

[30]Ibid., p. 351-357.

[31]See Wolfram Eberhard in John K. Fairbank, ed., Chinese Thought and Institutions (Chicago: University of Chicago Press, 1957), p. 69. In fairness, since portents were used as political weapons many times, in order to dissuade the emperor from this or that decision, they were not always taken seriously. Nonetheless, such activities did not promote science: "It is quite obvious that the specialists were interested only in the political application of their observations and not in philosophical reasoning or scientific abstractions."

[32]Jaki, Science and Creation, p. 29.

[33]Needham, p. 36, 56-57, 558.

[34]The Chuang Tzu, the second most important Taoist text, as quoted in Jaki, Science and Creation, p. 29. Wide variations of belief existed in Taoism, which included many practitioners of the Chinese peasantry's varied superstitions, not just philosophers like Lao-tzu. See N. Sivin, "On the Word 'Taoist' as a Source of Perplexity. With Special Reference to the Relations of Science and Religion in Traditional China," History of Religions, February-May 1978, p. 314.

[35]Jaki, Science and Creation, p. 29.

[36]Ibid., p. 30.

[37]Ibid., p. 42.

[38]Ibid., p. 43.

[39]Ibid. For a corrective and/or reply against Jaki's analysis here in general, see Wing-Tsit Chan, "Neo-Confucianism and Chinese Scientific Thought," Philosophy East and West, January 1957, p. 309-332.

[40]Needham, Science and Civilisation, p. 581

[41]Stanley L. Jaki, The Origin of Science and the Science of Its Origin (South Bend, Indiana: Regenery/Gateway, 1979), p. 79.

[42]Jaki, Savior of Science, p. 33. A somewhat different analysis as to why China developed no science due to its philosophy (in this case, its tendency to turn inward to know the mind and the individual, as opposed to the outside world) is found in Yu-Lan Fung, "Why China Has No Science--An Interpretation of the History and Consequences of Chinese Philosophy," International Journal of Ethics, April 1922, p. 237-263. However, a sociological explanation for the failure of modern science to arise in China involving what could be called "Mandarin bureaucratism," also exists. See Max Weber, The Religion of China Confucianism and Taoism (Glencoe, Illinois:

The Free Press, 1951), p. 150-152. Jaki's analysis doesn't hit on all the reasons why modern science did not arise in China, though I have stressed it here.

[43]as quoted in Jaki, Science and Creation, p. 230.

[44]John R. Gillis, The Development of European Society 1770-1870 (Lanham, Maryland: University Press of America, 1983), p. 13.

[45]As quoted in Jaki, Science and Creation, p. 7.

[46]Ibid., p. 8.

[47]Richard C. Dales, "A Twelfth-Century Concept of the Natural Order," Viator Medieval and Renaissance Studies, Vol., 9, 1978, p. 191-192.

[48]Jaki, The Savior of Science, p. 30; Jaki footnotes his source as the Jan. 6, 1983 International Herald Tribune.

[49]Lynn White, Jr., "Science and the Sense of Self: The Medieval Background of a Modern Confrontation," Daedalus, Spring 1978, p. 56-58.

[50]For example, Savonrola in Renaissance Florence condmened Florentines as believing in astrology more than God. See Richard C. Trexler, Public Life in Renaissance Florence (Ithaca, New York: Cornell University Press, 1991), p. 79. St. Augustine attacks astrology in Confessions (Middlesex, England: Penguin Books, 1961), p. 73, 139-142.

[51]Sydney Nettleton Fisher and William Ochsenwald, The Middle East a History (New York: McGraw-Hill Publishing Co., 1990), p. 99-116.

[52]Jaki, Science and Creation, p. 204-205. It is quite clear the traditionalist theologians beat out the Aristotlian philosophers culturally, because of the concept of bid'a, which saw any innovation as evil, except when the unbelievers used it in battle, which allowed you (the Muslim) to use it then. "In the Muslim tradition, innovation is generally assumed to be bad unless it can be shown to be good. The word bid'a, innovation or novelty, denotes a departure from the sacred precept and practice communicated to mankind by the Prophet, his disciples, and the early Muslims," Bernard Lewis, The Muslim Discovery of Europe (New York: W.W. Norton, 1982), p. 224.

[53]Jaki, Science and Creation, p. 206.

[54]Thomas F. Glick, "George Sarton and the Spanish Arabists," Isis, December 1985, p. 497. Glick notes how astrology was considerable stronger in the Islamic world compared to Christendom.

[55]Jaki, Science and Creation, p. 198-200, 206-7, 211.

[56]See the list of comparisons in Robert A. Morey, Islam Unveiled The True Desert Storm (Shermans Dale, PA: Scholars Press, 1991), p. 57-60.

[57]Morey, Islam Unveiled, p. 58.

[58]As quoted in Jaki, Science and Creation, p. 214

[59] As Jaki notes, Science and Creation, p. 230, 245.

[60] Ibid., 169-171.

[61] Ibid., p. 225-226.

[62] See A.G. Molland, "Medieval Ideas of Scientific Progress," Journal of the History of Ideas, Oct.-Dec. 1978, p. 562-564.

[63] Jaki, Science and Creation, p. 166-167, 175-176.

[64] Jaki, Science and Creation, p. 178-184. See also Molland, "Medieval Ideas," p. 562.

[65] Jaki, Ibid., p. 229. Also see Edward Grant, "The Condemnation of 1277, God's Absolute Power, and Physical Thought in the Late Middle Ages," Viator, Vol. 10, 1979.

[66] Jaki, Ibid., p. 237.

[67] Jaki, Ibid., p. 166.

[68] Lynn White, Jr., "Science and the Sense of Self: The Medieval Background of a Modern Confrontation," Daedalus, Spring 1978, p. 56.

[69] Jaki, Science and Creation, p. 229.

[70] Jaki, Science and Creation, p. 237.

[71] Richard C. Dales, "The De-Animation of the Heavens in the Middle Ages," Journal of the History of Ideas, Oct.-Dec. 1980, p. 534.

[72] Jaki, Science and Creation, p. 227. More on Roger Bacon and astrology can be found in: David C. Lindberg, "On the Applicability of Mathematics to Nature: Roger Bacon and His Predecessors," British Journal for the History of Science, March 1982, p. 22-24.

[73] Dales, "The De-Animation, p. 549-550.

[74] Ibid., p. 533.

[75] Jaki, Science and Creation, p. 225-226.

[76] Dales, The De-Animation," p. 550.

[77] Dales, Ibid., p. 547.

[78] Tina Stiefel, "Science, Reason and Faith in the Twelfth Century: The Cosmologists' Attack on Tradition," Journal of European Studies, March 1976, p. 4. Also see her article on a highly similar subject: Tina Stiefel, "The Heresy of Science: A Twelfth-Century Conceptual Revolution," Isis, September 1977, p. 346-362. In a useful corrective to Jaki, she points out the resistance faced by these innovators from other theologians or philosophers. Also along the same lines of a corrective, although it is rather speculative, is Manfred Gordon, "A Strategy For Medieval Science," Diogenes, Winter 1981, p. 70-93. These innovators did face serious opposition, even persecution, which should not be ignored.

[79]Jaki, Science and Creation, p. 240. Jaki notes that Oresme did not dispense with the notions the heavens had intelligences, but this metaphor certainly leads in this direction.

[80]Ibid., p. 226.

[81]H. Butterfield, The Origins of Modern Science 1300-1800 (London: G. Bell and Sons Ltd., 1949), p. 8-9.

[82]Jaki, p. 53, Savior of Science.

[83]Dales, "The De-Animation," p. 547. However, note that Dales points out that Buridan still was largely Aristotlian in outlook. A similar point is made by A. C. Crombie in Augustine to Galileo, vol. 2, Science in the Later Middle Ages and Early Modern Times XIII-XVII Centuries (Cambridge, MA: Harvard University Press, 1961), p. 66-73. Hence, Buridan was only making the first steps, it must be stresse

[84]Thomas F. Gieryn, "Distancing Science from Religion in Seventeenth-Century England," Isis, December 1988, p. 590.

[85]Merton, "Science," p. 420-459 for general statements in this section.

[86]Ibid., p. 423.

[87]Ibid., p. 423.

[88]Gieryn, "Distancing Science," p. 590.

[89]Merton, p. 445.

[90]Merton, p. 471-473.

[91]Merton, p. 452.

[92]Merton, p. 459.

[93]Theodore Rabb, "Religion and the Rise of Modern Science," p. 126.

[94]H.F. Kearney, "Puritanism, Capitalism, and the Scientific Revolution," Past & Present, July 1964, p. 100. One valuable article on the Merton thesis is: Steven Shapin, "Understanding the Merton Thesis," Isis, December 1988, p. 594- 604;

[95]Gillis, Development of European Society, p. 13.

[96]W.W. Rostow, How It All Began Origins of the Modern Economy (New York: McGraw-Hill, 1975), p. 159.

[97]Ibid., p. 132.

[98]Ibid., p. 155.

[99]Ibid., p. 156.

[100] A.E. Musson, ed., Science, Technology, And Economic Growth in the Eighteenth Century (London: Metheun; 1972), p. 62-63.

[101] Ibid., p. 60-61

[102] T.S. Ashton, The Industrial Revolution 1760-1830 (London: Oxford University Press, 1948), p. 16.

[103] Musson, Science, p. 90.

[104] Musson, Science, p. 90.

[105] Ibid., p. 77.

[106] Rostow, How It Began, p. 158.

[107] H.G. Wells, The Outline of History Being a Plain History of Life and Mankind (Garden City, New York: Garden City Books, 1956), vol. 2, p. 829.

[108] Musson, Science, p. 177, 181-183.

[109] Musson, Science, p. 64.

[110] Merton, p. 506-513.

[111] Merton, p. 526-533.

[112] Ayn Rand, For the New Intellectual (New York: New American Libarary, 1961), p. 27. Of course, she is sharply differentiating the two groups (businessmen and scientists) here, which reflects the contemporary situation of greater occupational specialization in the mid to late twentieth century as opposed to the time of the industrial revolution.

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