A REEXAMINATION OF THE STRUCTURE OF SCIENTIFIC REVOLUTION AND APPLICATION: THE RISE OF MATHEMATICAL ECONOMICS

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A REEXAMINATION OF THE STRUCTURE OF SCIENTIFIC REVOLUTION AND APPLICATION: THE RISE OF MATHEMATICAL ECONOMICS

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DISSERTATION ABSTRACT

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Abstract: I propose to reexamine the works of History of Science writers, specifically Thomas S. Kuhn. Kuhn's theory is susceptible to contradiction when applied to itself. Is "The Structure of Scientific Revolution" nothing more than a scientific revolution itself within the field of the history of science? Kuhn's theory is itself both on analytic foundations and incomplete. A defense of a synthetic foundation for the theory of scientific revolution will be put forth. This theory will bring the history of science into economics. This theory will be applied to the rise of mathematical economics and relate it to the growth of government and corporate institutions in the United States.

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CHAPTER I: INTRODUCTION

In trying to answer the question of why did mathematical economics become dominant in the field of economics a number of previous questions must be answered. These questions begin with philosophical matters. In order to discuss the history of economics it is first necessary to determine whether or not it is a science. If it is then one should be able to analyze economics within a broader theory of the history of science. Once one has an adequate general theory regarding science and the rise and descent of paradigms within a science, it should then be useful, in accomplishing the task of a historian of thought within the field of economics, to discover and explain this phenomenon within economics proper. Only in this way can a truly scientific explanation of the rise of mathematical economics be undertaken.

This dissertation is an attempt to accomplish the tasks outlined above. To do so, it is first necessary to define science and economics in a truthful manner and to relate the two. Is economics a science? It will be maintained that economics is a science and, as such, discussions of the rise and fall of paradigms must be discussed under a general theory regarding the history of science.

As noted before, an adequate general theory of science must be used. Previous writers have assumed that the physical sciences (physics and chemistry for example) are the more general, or the ideal, form of science and that the social sciences must emulate

them.[1] It is as though the social sciences are somehow lacking in the awesome light of the physical sciences. This dissertation will attempt to turn this idea on its head. Rather than being the redheaded stepchild of the sciences, the social sciences are the more general form and the more theoretically developed form of science.

For this reason, it will be proposed that a reexamination of the history of science be in order. The idea that the form and substance of how the physical sciences are performed, methodologically, is not the ideal form of science, but rather an inferior form of science will be examined and supported. Previous works on the history of science will be examined, specifically the work of Thomas Kuhn. This reexamination will be accompanied by a restructuring. This restructuring will attempt to integrate synthetic foundations to Kuhn's work, to work out any differences in his theory in accordance with the ideas expressed above, and to improve on various aspects in light of the previous ideas.

Some of these improvements will focus on the triggers for scientific revolution. Kuhn is vague on the necessary problems that will trigger revolution within a science. The integration of an economic analysis of ideas, their usefulness, and the demand for them will shed some light onto the actual process that triggers scientific revolution.

Although I propose a general theory on the history of science, the intention of this proposal is to develop this general theory in order to use it as a foundation for works in the history of economic thought. Before one can discuss the significance of various thinkers, or determine where their thought must be placed into the history of economic

[1] See, Milton Friedman, "The Methodology of Positive Economics," in *Essays in Positive Economics*, (Chicago: University of Chicago Press, 1953).

thought, this general theory on the history of science must already be available. This proposal is intended to provide the foundation for paradigm analysis.

The subject matter of this analysis will be the rise of mathematical economics. This use of the word mathematical is to differentiate the specifically mathematical form of economics from the quantitative form. The use of the word increase or decrease, say in price, is differentiated from numerical changes in price, for example from $2/ unit to $3/ unit.

In economics, price theory is a foundation for discussing certain activities of human beings. Economics is the science that discusses human behavior as a relationship between ends and scarce means that have alternative uses.[2] Price theory discusses the relationships between goals and property. Price theory establishes relationships between goals (ends) and physical objects such as cars, corn, and ores, and non-physical things such as time. What we call utility is a word that describes the relationships between goals (ends). Whenever an economist discusses price theory, he is discussing a relationship between these mental things (goals and utility) and physical things[3] (cars, corn, ore, and labor) and non-physical things such as time). In the physical sciences, the nature of the objects under discussion are things extended in time and space, while in the social sciences things are not always extended in either time or space. Economics discusses the actions of free willed individuals, while in the physical sciences the relationships discussed do not include the free willed actions of sentient beings. The natures of the

[2] See, Lionel Robbins, *An Essay on the Nature and Significance of Economic Science* (New York: New York university Press, 1984).

[3] A material thing is a thing which is extended. Material activity is the activity of a material thing. Sensation is the perceptive act of a sense; that is, it is the act by which a sense perceives or represents a material thing or a material activity. From, John J. Toohey, S.J., *Notes on epistemology* (Origin of manuscript unknown). P. 19.

things for which relationships are being discovered are different in the two types of science. This proposal will examine these differences and attempt to combine the study of the history of science, for both the physical and the social sciences, into one general theory.

After forming a general history of science, an attempt will be made to apply this theory to the rise of mathematical economics. The beginning section of this proposal will be the framework through which questions such as, whether or not the rise of mathematical economics is an advance over previous paradigms, and if its rise is attributable to the rise of the state, will be answered.

Science

The research contained in this dissertation will involve a discussion of philosophical issues that apply to any discussion of science, methodology and human endeavors. The meaning of science is a key point in this dissertation. What is it that makes something a science and scientific? Is it the application of the scientific method, or is the scientific method only a part of science? Is realism a necessary component of science, or can we use assumptions that contradict or at least do not coincide with reality to derive theory? These questions will be addressed and a coherent definition of what science is will be attempted. This definition of science will be very useful in the development of a history of science.

It would seem odd to develop a history of science without a coherent definition. This emphasis gives away the answer to the question of realism in science. Could we possibly explain the development of science if it were somehow acceptable to distort science through a definition that did not correspond to the nature of the topic under

discussion? While we can define things that do not, and have not existed, such as the phoenix of mythology, we cannot use the nature of a phoenix to explain or predict the behavior of elephants or human beings.

The nature, or essence, of things is what defines them and what is affected in the relationship between one thing and another. This is the foundation of science, discovering things, their natures, and the relationships between things. As will be shown later, anything else would be contradictory.

Epistemology

Also in chapter 2, a discussion of epistemology will be undertaken. This is a crucial element in the discovery of a theory regarding paradigm shifts and being able to relate old and new paradigms within a science. Knowledge will be defined and the conditions under which knowledge exists will be examined.

After defining knowledge, a key aspect of that definition is the justification for assenting to a proposition. While working within a Thomistic framework, the knowledge distinction known through Kant's box will be integrated into the Thomistic framework. In addition, the use of Kant's box will enable us to compare and critique various competing epistemologies with the Thomistic/Kantian framework used in the dissertation. After critiquing various competitors, it will be maintained that Kant's Box allows for an answering of what constitutes a good reason for assenting to a proposition.

A defense of the existence and usefulness of synthetic *a priori* propositions will also be undertaken. An examination on how such truths are discovered will be included as well as integration within the Thomistic framework. Some discussion regarding Kant's claims on these propositions will be examined. What statements meet the requirements of

a synthetic statement and thus possess operationality? How do they relate to observation? Kant's Box can be viewed through the Thomistic framework as describing the formation of logical truths, additions to our stock of knowledge; it is this process that adds insight to the Thomistic framework. The extents of various propositions are contained in Kant. First principles, according to Aristotle, are the end goals of induction. In what way can these first principles be discovered and related to synthetic a priori statements? Various writers have maintained that induction can never lead to true universals, and that a pure theory, as described by Aristotle[4], is not possible. It will be proposed that the link between induction and universals lie in the elimination of alternatives and the birth of ideas, which can be considered as universals and validated through reflection. While this may be a long road to a pure scientific theory in the physical sciences, it is less difficult to do in the social sciences. In the social sciences, the theoretician can know what it means to be human and examine our own nature, including our mental structures. In doing so, through self-reflection, a form of induction, one can arrive at synthetic a priori propositions about the world in which we act (the mind-dependent world). [5]

[4]See, David Gordon, *The Philosophical Origins of Austrian Economics* (Auburn, Al.: Ludwig von Mises Institute, 1993) p. 27. See P. F. Strawson, *The Bounds of Sense: an Essay of Kant's Critique of Pure Reason* (London: Harper and Row, 1975).

[5] I believe it is also possible to come up with axioms concerning the physical mind-independent world. However, this task is much more difficult and classifications and observations of phenomena can lead one to the formation of ideas that can then be examined logically, in the absence of testing to discover an axiomatic proposition through reflection concerning the material object in the mind-independent world, its nature, and the logical possibilities concerning it and a proposed axiom. It could be possible to rule out any possible exception to this proposition, an indirect proof. If logic is a useful tool, which it is maintained that it is, in understanding reality, it should be possible to determine if some axiomatic propositions are true, independent of testing, about mind-independent phenomena. This dissertation is not intended to accomplish this. But such a task would be fruitful for future research.

History of Science: Thomas Kuhn

An examination of Thomas S. Kuhn's theory on the history of science provides an incomplete and foundationless examination of the history of science. This paper will be an attempt to reconstruct Kuhn on a solid foundation. This foundation will be the fundamental category of action. This will establish a new theory on a footing that, unlike Kuhn's theory, will be based on synthetic foundations. The history of science will be presented as an economic process. Scientists, regardless of whether they may like the label or not, supply new ideas, these ideas are not demanded necessarily on their truthfulness. Instead they are demanded to use in the accomplishment of some goal. That goal may be to build a bridge, enabling travel across a previously uncrossed river or gorge, or as justification for some policy or plan. Ideas are demanded and supplied; the process of new idea creation is an economic one.

Kuhn points out that science is learned through the eyes, so to speak, of the dominant paradigm in times of intellectual peace. The history of a science is learned through texts written by individuals of the dominant paradigm and through classics chosen by the same. Any field of science is dependent on certain presuppositions. Kuhn describes the validity of these presuppositions as arbitrary. This would indicate that the foundations of science according to Kuhn are analytic. This could be a result of Kuhn coming from a physical science background (physics). This would also leave Kuhn's analysis as another conclusion drawn from arbitrary, or subjective, premises. In the social sciences the existence of synthetic *a priori* truths has been a long-standing tradition.[6] An attempt will be made to solidify elements of Kuhn's theory along grounds, which are

[6] Other classic examples are geometry and optics.

synthetic and eliminate the claim that the theory of *The Structure of Scientific Revolutions* is nothing more than a new revolution itself, and not a necessary improvement in our knowledge about science (arbitrary).

If the theory of the history of science can be established on firm foundations, we can attempt to create criteria out of which to define the aims and uses for science. Some goals are clearly empirically grounded. If I want to build a bridge, a simple empirical test is used to establish the ability of a certain bridge to fulfill this goal. Does it stand? Can cars pass over it? After repeated instances of a bridge design's ability to fulfill these criteria it becomes accepted that it will continue to do so and the technology underlying this design may become accepted.[7]

In the social sciences we do not have these simple empirical grounds, due to the absence of control in experimentation, to base our acceptance of theory. An examination into the driving force behind the revolutions in economics will be undertaken. Where the practical demands placed upon economics changed as a result of the increase in the size and scope of government in the US. Did government intrusion into education and the changing nature of the role for universities alter the method and aims of economics and cause revolution in the field of economics?

[7] The use of the word accepted will be further explained later. However, it is important to note here that I am not using it in relation to truthfulness. Later I will maintain that truthfulness and acceptance are two different concepts. I refer to acceptance here in relating the idea to the accomplishment of some goal. It could very well be that what is accepted is false in this regard. I want to make it perfectly clear that acceptance is not being used in reference to accepting and thus not rejecting the truthfulness of scientific theory such as through the use of the scientific method. As we all know, theories are never accepted through experimentation using the scientific method, only rejected, or failed to reject based on the comparison of results and hypothesis resulting from a theory.

Reestablishment of Kuhn on Synthetic Grounds

In the fourth chapter Kuhn's theory will be reworked on synthetic grounds based on the ideas of the first three chapters. In this chapter the fundamental concepts of action, scarcity and errors will be used to develop a firm theory on scientific paradigm shifts. This theory will be presented in the absence of Kuhn's nihilism.[8] Some basic concepts will be reexamined, specifically what the causes of scientific revolutions are. An attempt will also be made to establish criteria on judging the progress of science. Is a particular paradigm shift an advance over a previous paradigm?

In this chapter the study of scientific revolution will be placed under a broad umbrella. Economics will be established as a corner stone in the examination of paradigm shifts. Science is a process through which truthful propositions about what exists, how it exists and how one thing exists in relation to others are developed. As an 'accepted' set of rules governing research, paradigms are generally accepted methods through which one attempts to answer these questions. In attempting to answer these questions a paradigm may, or may not, demonstrate usefulness in the accomplishment of human goals. If a perceived causal relationship exists between a scientific theory and some human goal, then a theory, and or paradigm from which it came becomes accepted.[9] If the

[8] While Kuhn's nihilistic tendencies are not original to this work, they are a hindrance to the universal application and acceptance of his work. It is hoped that this dissertation can be useful in establishing the truthful and useful portions of Kuhn's work, while reworking and correcting those portions that rely on his nihilistic views. I have made the point earlier that in light of Kuhn's nihilism it would be a valid critique of his work to assert that it itself is based on nothing but arbitrary, or non-operational, analytic foundations. And in light of Karl Popper's work neither testable, not falsifiable. I will make the claim, and defend it, that falsification is not a valid definition for science, and that true scientific theory must be based on synthetic a priori foundations.

[9] In order for action to take place three conditions must hold. Their must be a human need, a plan to organize other factors into a cause and effect relationship with the satisfaction of that need and the scarce means available in the correct quantities to accomplish the satisfaction of the human need. Science is useful in that it, when applied, supplies the technology, or the plan, with which to accomplish goals satisfying human need.

relationship holds, only then does it become useful. There is a difference between a useful idea and one that is merely perceived to be useful.[10] When an idea that we accept and use as a plan is an ontological truth it is also a logical truth. In the absence of this identity between what is assented to and ontological truth, error is the outcome.[11]

The acceptance of a theory is not, a priori, based on its truthfulness, but rather on its perceived usefulness. Paradigm shifts occur based on this concept. Science is demanded and supplied. Science, like any other good, is demanded based on a perceived ability to satisfy human needs through its usefulness in accomplishing goals. The paradigms of science are dictated too through the market for ideas. The demand for science is determined external to the community of scientists. While this is not to say that scientist have no role in the paradigms they choose, it is to say that the demands of the non-scientific consumers of their product have a major role in determining their form. The questions asked, and the attempted answers to them are the results of an interaction between demanders of science and scientists themselves. This influence has been increased due to the increasingly professional role that the activity of science has taken on. In the last few hundred years the role of scientist has changed from the independent scholar gentleman to a professional scientist working in a university setting, or government agency funded by tax dollars or corporate scientists funded by a business entity intent on profiting from the work of scientists. In both cases, there is a demander of scientific, or pseudo-scientific, research more than likely different from the researcher.

[10] The acceptance of a false theory or the acceptance of a true one misapplied, leads to the commission of errors. In this case, what was viewed as useful, is, in fact, later found to not be useful in accomplishing human goals. These errors are what must be minimized in the progression of human endeavors. Economic growth, profit and economic variations are related to error. An increase in human knowledge requires that we also minimize error. An increase in knowledge caused by one paradigm replacing another must be the result of a decrease in the number of errors accepted in the new paradigm versus the old.

The results of such research are believed to have a role in the accomplishment of goals believed to be important by the institutions that pay the scientists salary.

Often times, the goals of these institutions may not be the discovery of a true cause and effect relationship, but rather justification for some action, or policy that the individuals in control of these institutions may want to undertake. These range from future investment decisions of a firm, the valuation of non-market goods, or to the implementation of some government program, or change in the relationship between the state and the governed. In these cases there is a bias in the demands for science. A paradigm that enables these types of prediction, or justifies the desired ends of the demanders will be accepted at the expense of a paradigm that does not give the desired predictions or justifications. It is in these instances that there is pressure for scientists to practice paradigms based not on their truthfulness, but rather on their ability to satisfy the previously stated goals.

Science is a powerful tool in the task of convincing others of the necessity of a policy or plan. Individuals within firms and governments, and those who wish to influence others within an institution, demand science to back up their plans and policies. These plans and policies may themselves be based in error, or in truth. As such, individuals belonging to various non-academic institutions can influence science through the demands they place upon the scientific community. The support for science and scientific activity comes from outside science, especially with the virtual extinction of the gentleman scientist. Science has become a market activity; as such it is directed by the

[11] This concept will be further defined and discussed in chapter 2.

demands for it from the outside. Large demanders of science can indeed make dictates to it.

Scientific discovery is not a distinct or separate function from society as a whole. The value of scientific discoveries is dependent upon their acceptance and usefulness in the accomplishment of human goals. Technology is a plan for combining resources into the eventual production of consumer goods. Consumer goods are those things directly useful in the accomplishments of goals. Producers' goods are those goods indirectly useful towards the satisfaction of human goals. Technology is one example of a producers' good. As such the value of an idea is based on its future usefulness in producing some consumer's good. This consumer's good must be perceived at least to be useful in satisfying some future human goal.

In being a factor of production, the value of science is based on there being a perceived relationship between it and the satisfaction of some future end. The vast majority of scientific activity is not directed towards the use of its discoverer, but rather to the satisfaction of others.[12] This relationship implies that scientists are attempting to satisfy the goals of those who fund their activities. Universities, governments, those who wish to influence governments or societies, and firms fund research. In doing so they make an entrepreneurial decision on what paradigms within a science will satisfy their goals and which will not. Funding for science is based on the demands of its consumers.

[12] It is true, that some scientist may feel satisfaction in their discoveries, however, the vast majority do not fund their own research, rather than research is funded by others, states, private firms, or research groups, in the hope that it may be useful to them.

In the United States, governments (federal, state and local) either directly, or indirectly, fund the vast majority of universities. In doing so, they employ a vast number of scientists within the United States. This constitutes a large portion of demand in the market for science and ideas within the academic market. A science that produced predictions, that continually contradicted the goals of individuals within governmental institutions governing these universities and/or controlling their funding, would face a lowered demand. This would be true, especially in light of a science that produced the predictions and justification required by the individuals within governmental institutions that governed these universities and their funding. This is not to say that all science demanded by these individuals, within governmental institutions, is false. Rather that a paradigm, within a science that produced the type of predictions necessitated by the goals of its demanders, is more useful to those who fund scientific activity than a paradigm that does not.

Examples of this will be given in economics. The mathematical approach to economics provides numerical estimates of future prices and prices for non-market goods. For instance, there are no market prices for the FBI's services[13]. What is the value of this service to non-paying customers? A paradigm that answered these questions would be useful to individuals within the FBI and government. They might be useful in allocating resources in a non-market environment, or as justification for an increase or decrease in the allocation of resources for the FBI. How accurate these predictions are is a second question, but a paradigm that does provide numerical estimates of these services

[13] This is a simple example. It is noted that national income procedures value these "goods" in accordance with their costs. This is in contrast to market goods in which a good is voluntarily exchanged through a market and can be valued in accordance with the price paid for it.

would be, all other things being equal, superior to one that did not. Mathematical economics provides these sorts of estimates.

An Application to the Rise of Mathematical Economics

Having developed a general theory on the history of science in the final chapter, this theory will be applied to the rise of mathematical economics in the United States. As the size and scope of government has increased, so has the need for theories justifying this rise and to administer the increasing number of bureaucracies and departments. In addition the rise of the large corporation placed similar demands on economic science. In both cases the need for valuations of non-market goods and services was evident. The rise of the state and the rise of the large corporation will be compared with the rise of mathematical economics.

An attempt will be made to establish a causal relationship between the growth of the state and the vertically integrated large-scale corporation with the rise and development of mathematical economics. In doing so, documentation regarding the rise of mathematical techniques in economics will be presented prior to and after 1930. We will note a distinct increase in the use of mathematics, corresponding to a rise in the size and scope of government power and influence. Also, a trend will be documented in the increased size and scope of corporate enterprises. These facts coincide with an increased presence of the state in the provision of post-secondary education. The theory presented in chapter 4 will be applied to this period of time. This examination will hopefully explain the rise of mathematical economics in relation to the special needs required of interventionist government bureaucracies and the bureaucracies of large corporations.

In the presence of special needs regarding the valuation of non-market goods and services, scientific backing for judgments regarding future demands and conditions, as well as justification for policies and plans, present in large corporate and governmental agencies this created a demand for certain mathematical predictions and valuations. The entities described above through their funding of post-secondary education skewed the demand for economic paradigms into the mathematical direction. Mathematical economics, by its very nature, provides estimates and valuations of a numerical nature that are perceived to be useful in accomplishing the distinct needs of large government and large corporate managers. These facts lead to the establishment of mathematical paradigms as the dominant paradigms in economics.

CHAPTER II: PHILOSOPHY

To Know

"There is a fairly general agreement that the following are necessary and sufficient conditions of X's knowledge that p. (I) p must be true. (ii) X must believe that p, in the sense that he sincerely asserts, or is ready to assert, that p. (iii) X must be in a position to know that p.[1]

To begin any discussion, it must first be agreed upon that knowledge is possible and under what conditions it takes place. It would be a clear contradiction for one to assert that we cannot know anything. For in doing so, the speaker has maintained that this proposition is itself true and that he knows it is true. Thus he has performed a contradiction, using something, in this case, an assertion of knowledge, to prove, or convince others of its non-existence.[2]

Above is Antony Flew discussing the general acceptance of what it means to know something. This very idea is a presupposition to knowledge. How could one know anything, if he did not first know what it meant to know? The conditions under which knowledge is possible must first be known, before additional knowledge can be discussed.

This definition will provide the foundation upon which the investigation of epistemology, methodology, and science will take place. Of the three conditions above,

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[1] Antony Flew, *A Dictionary of Philosophy, Revised Second Edition* (New York: St. Martins Press, 1984) p. 194.

[2] In making an assertion, one is asserting that what one says is true. Otherwise, it would be meant to be nothing more than an utterance. Since it is obviously true that one could assert something that is untrue, it is not the case that everything we assert must be known. One could not know that a ball was both red and

(I) and (iii) provide some controversy. Condition (ii) is the least controversial. The word assent will be used as in the definition "Assent is the mental assertion of a reality or something taken to be a reality . . . Assent is more loosely defined as the acquiescence of the mind in a proposition as true, or the acceptance by the mind of a proposition as true."[3] In order to discuss condition (i) a definition of true will be undertaken later in this chapter. To what statements is the word true applied, can we come up with a definition that accommodates both the philosopher and the common speaker of the word. The works of Father John J. Toohey will be put forward to answer this question.

The final condition (iii) is the condition that sparks the most controversy. Antony Flew, in *A Dictionary of Philosophy, Revised Second edition,* continues the above passage by discussing the controversy regarding condition (iii). "But, even if the conditions are sufficient, there is much room for debate as to what (iii) properly involves."[4] A major section of chapter 2 will involve a detailed description of what constitutes condition (iii). An integration of Thomistic epistemology and a reinterpretation of Kant's knowledge distinctions will reveal that different types of knowledge require different methods for satisfying condition three. This will fit in with the framework laid out by St. Thomas Aquinas commenting on a passage by Boethius from *De Trinitate*.[5] In "On Natural Science, mathematics and Metaphysics," St. Thomas Aquinas discusses the relationship between objects under consideration and our minds grasping them. He maintains that in order for a discussion to take place we must take into

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non-red all over at the same time in the same respect. Such a statement is obviously false, but one could assert it and thus not know it, since it is untrue and not capable of being known.

[3] John J. Toohey, S.J., *Notes on epistemology* (Origin of manuscript unknown). P. 3.

[4] Antony Flew, *A Dictionary of Philosophy, Revised Second Edition* (New York: St. Martins Press, 1984), p. 194.

account both the nature of the thing under investigation and our own, human, nature. Only in discussing things in consideration of both can we discover truths about things.

In order to discuss adequately the history of science, metaphysics must be brought in to the discussion. Any hostility or ignorance of metaphysical foundations would lead one into an anchorless and random search of mysticism, on a voyage from nowhere to nowhere with no route to get there. In the absence of a discussion of reality and truth, one would be foundationless and in search of an undefined objective. This clearly leads to problems, especially those noted in the first chapter regarding the arbitrariness of theories. A discussion of ontology is of importance when one discusses science.

Ontology

> Ontology. 1. The branch of metaphysical inquiry concerned with the study of existence itself (considered apart from the nature of any existent object). It differentiates between 'real existence' and 'appearance' and investigates the different ways which entities belonging to various logical categories (physical objects, numbers, universals, abstractions, etc.) may be said to exist.[6]

A discussion of ontology must take place, specifically regarding the existence of useful a priori propositions in science. Can theory be more than a collection of non-operational assumptions manipulated through logic to form testable, yet arbitrary assumptions? It will be maintained that this question can be affirmatively answered in the positive. The existence of universals will be put forward and defended. In fact, it is by ignoring metaphysics and coming to false assumptions regarding universals that the

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[5] St. Thomas Aquinas, "On Natural Science, Mathematics and Metaphysics," *Selected Philosophical Writings*, trans. Timothy McDermott (Oxford: Oxford University press, 1993) p. 1-2.

[6] Antony Flew, *A Dictionary of Philosophy, Revised Second Edition* (New York: St. Martins Press, 1984) 255-256. Flew also includes a second definition on page 256 "2. The assumptions about existence underlying any conceptual scheme or any theory or system of ideas. Widely differing assumptions about 'what there is not' and 'what there is', are found in Parmenides and Plato, in Leibniz and Kant, and in modern phenomenological and analytical schools.

community of science can be driven into a wrong direction. As will be put forward later, science is much more than the scientific method, its theories can be much more than testable, yet unproven arbitrary hypothesis. Using the ideas expressed in this chapter a reconstruction of Thomas Kuhn's theory of scientific revolutions will be constructed, a theory that will not be susceptible to the criticism of arbitrariness.

Reality and Truth

In order for science to be considered apart from witchcraft, or alchemy, and to distinguish it from other human actions, it must be a quest for truths about the real world. Thus definitions are needed for both reality and truth. In his article "Reality and Truth,"[7]

Toohey points out that there would be no need for definitions for these words, "if philosophers had not quarreled over their meaning."[8] He also sets out to define the words in terms of their common usage.

> The first point to be insisted on is that these words are not exclusive possession of the philosopher, and therefore, the philosopher is not at liberty to give them any meaning he pleases. They are on the lips of all men, even the most ignorant, and the ignorant man's use of them does not differ from that of the educated. Consequently, if the philosopher is to construct a definition of these words, he must be guided by the common man's use of them.[9]

Toohey, in Thomistic fashion, appeals to the common usage of the word in providing a definition that the philosopher can use for the words truth and reality. In doing so, he maintains that these words do have some concrete meaning in relationship to our minds and the external world. In defining reality, he is establishing a definition of that which science and man tries to establish relationships within. Toohey then asserts that in the absence of deception and error, we would not need to define these words.

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[7] John J. Toohey, "Reality and Truth," *The Philosophical Review*, v. 48, issue 5 (Sep., 1939), 492-505.
[8] Ibid., p. 492.
[9] Ibid., p. 492.

> The second point to be noticed is that the words 'reality' and 'truth' would hardly have been invented if men had not fallen into error. If men had never been deceived and had never attempted to deceive, there would hardly have been any occasion which would call for the use of these words. At any rate, it is certain that one of the primary functions is to express approval. 'Real' and 'true' are primarily words of approval; 'unreal', 'merely apparent' and 'false' are words of disparagement. 'Real' and 'true' are primarily employed to indicate that there is no mistake or no possibility or likelihood of mistake. 'Unreal', 'merely apparent', and 'false', are used when there is a mistake or something calculated to deceive or a suggestion of something which cannot be.[10]

Father John Toohey sets out to accomplish the task of coming up with definitions for these terms. In doing so, he believes that there are three types of truths, logical truths, ontological truths and moral truths. The following explanation regarding the three types of truth comes from a manuscript by Fr. John J. Toohey, S.J., *Notes on Epistemology*.

> In order to construct a real definition of logical truth, the first step is to determine the application of the term "true", when it is used to denote truth of thought. Unless we first fix the application of the term to be defined, our definitions almost certain to embrace objects which are not denoted by the term or to exclude objects which are. We know that the word "true," in the sense of truth of thought, is never applied to an apprehension or an idea, and hence our definition must not apply to apprehension. When a man merely utters the word "sleep" or "competition," we do not say he speaks truly. But we do say that he speaks the truth when he says, "Man is rational," and also when he says, "If it is raining, the streets are wet". Hence our definition of logical truth must be applicable to judgment and the act of inference and to them alone. The real definition, then, of logical truth, worded abstractly is as follows.
>
> Logical Truth is the identity of what is assented to with reality. A man possesses logical truth when what he assents to is a reality.
>
> In some textbooks logical truth is defined as the conformity of the mind with reality. But this definition is inaccurate. Strictly speaking, conformity demands a distinction between the things which are conformed. An idea or a mental representation is conformed to reality; but what the mind assents to is not the mental representation, but the thing which is represented, and this thing is a reality or something taken for a reality.[11]

> 10. But not only do we use the word "truth" when a man assents to a reality we use it also in such statements as "He is searching after the truth," "The truth gradually became clear to him." In these propositions the word "truth" evidently does not mean the identity of what is assented to with reality, and hence it is not the same as logical truth. The truth which is here spoken of, as is plain is the truth of things. The scientific name for the truth of things is Ontological Truth or objective truth. The real definition of this term, worded abstractly, is as follows:
>
> Ontological or objective truth is the aptitude of reality to be assented to or to be known. Concretely, the definition would run as follows:
>
> An ontological truth is a reality which can be assented to or a reality which can be known.

[10] John J. Toohey, "Reality and Truth," *The Philosophical Review*, v. 48, issue 5 (Sep., 1939). p. 492.
[11] John J. Toohey, S.J. *Notes on epistemology* (Origin of manuscript unknown). P. 4.

> 11. The word "truth," again, is applied to speech, as when we say, "The man spoke the truth", meaning that he did not tell a lie. Truth of speech is called Moral truth. A more abstract name for moral truth is Truthfulness or veracity. The real definition of moral truth is as follows:
>
> Moral truth is the identity of what is said with what is assented to. It is the identity of what is said about a thing with what is thought about it. A man speaks the truth, when he says what he thinks.
>
> N. B. If what a man says is identical with what he assents to, and if what he assents to is identical with reality, his statement is not only morally true, but logically true.
>
> 12. Logical falsity is the diversity of what is assented to from reality. There is falsity in the mind when it assents to an unreality, that is, to what is not.
>
> Strictly speaking, there is no such thing as ontological or objective falsity. If we wish to use words loosely, we could say that an ontological falsity is an unreality which can be assented to.
>
> Moral falsity or falsehood is the diversity of what is said from what is assented to. A man utters a falsehood, when what he says is not what he thinks.
>
> N. B. If what a man says is identical with what he assents to, and if what he assents to is different from reality, his statement is morally true, but logically false.[12]

We will come back to this quote later on in a discussion on acceptance, usefulness and truth, for now these three distinctions are important to foreshadow the relationship between the truth and science. Universals are things that exist as ontological truths. In order for science to discuss them they must be accepted, becoming logical truths, and discussed, in an identity to the original logical truth, becoming moral truths.

Fr. Toohey also discusses reality;

> We may now inquire what it is that determines a man to pronounce one object real and another unreal. The answer to this question will put us in a position to define 'reality' without reference to the suggestion of an object to the mind, though the definition of 'unreality' will be impossible without that reference. We will suppose that the man is justified in deciding in the one case that the object is real and in other cases that it is unreal. He calls the object real when he sees that the elements of attributes which are suggested as being in the object are in the object. He calls it unreal when he sees that the elements *are* not in the object. He knows that an object cannot be composed of elements which exclude each other. When, upon examination, he notices that certain elements of the object exclude others which have been suggested as belonging to the object, he pronounces the suggested combination of elements unreal or merely apparent. The presence or absence of a suggested element or collection of elements is his *test* whether the object is real or unreal. This consideration will enable us to define 'reality' and 'unreality' as follows:
>
> A *reality* or a *real object* is one which is made up of elements or attributes which coalesce into unity, that is, into one object. To put it more accurately and concretely, a reality is an object which is such and such and such . . . .
>
> An *unreality* or an *unreal object* is a number of elements which are suggested as coalescing, but which do not coalesce, into unity; or it is an object which is suggested as

[12] John J. Toohey, S.J. *Notes on epistemology* (Origin of manuscript unknown). P. 4-5.

> being such and such, but is not such and such. We may put it this way: An unreality is a suggested coalescence of elements which do not coalesce.[13]

The description of reality above is not an idealistic concept. Toohey is not suggesting that there would be no reality in the absence of suggestions about it. Instead Toohey is pointing out that reality is things as they are. His definitions are a response to the fact that we would not have discussions about it in the absence of error and deception. The word reality is used when we are discussing the relationship between our thoughts and suggestions with reality. A thing in being defined and discussed is always held against what it is meant to represent in reality (whether that be a mind-dependent or mind-independent one). Can what is said of a thing be a correct representation of that thing. Thus something is a reality when the elements or attributes suggested of it do coalesce into a unity. All elements suggested do not exclude any of the others. The object is such and such. An unreality in being discussed is an object in which the elements or attributes do not coalesce into unity. Reality is as a thing is independent of its being known, or discussed.

Real objects when discussed are merely objects in which what is suggested of them coalesces into unity. In other words no element or attribute excludes the possibility of one or more of the other attributes from being a part of the object. In other words A and B make up C. A and B are possible and coalesce into the unity of C. An unreality is when one says D and E make up F, but D or E implies the absence of the other. For example, a ball that is both red and non-red all over at the same time in the same respect

[13] John J. Toohey, *Notes on Epistemology* (Ann Arbor, MI: Edwards Brothers, Inc, 1946). P. 9. This discussion in no way asserts idealist conclusions regarding reality. Only the use of the word reality is a predicate to some other thing. When one discusses something as a reality he is asserting that the things being said of it coalesce into a unity.

is an unreality. The presence of red all over implies the absence of non-red on any part of the ball in the same respect let alone all over.

It is also noted that an object, for which the suggested coalescence of elements which cannot coalesce, are not unreal, merely their coalescence is unreal.[14] Dreams and allusions must also be considered realities, since ". . . they are events which actually occur. It is only when they are suggested to exist as external physical events or otherwise as being what they are not that they deserve to be called unrealities, for in that case they are not such as they are suggested to be."[15] This point made by Toohey points to the fact that there can be real things, in thought, that do not occur external to the mind. In addition, our minds can be the victims of a false sense, or interpret a sense incorrectly; in this case an error has been made if it suggested that the objects of such claims are not in fact that which they are purported to be. This concept of error will be of importance later when we discuss science. The human mind is not immune to error. Error is in fact a part of our nature.

Some objects can be suggested that we cannot determine their realness, or unrealness, in this case we call these objects problematic objects.

> *Problematic object*, which may be defined as a suggested coalesce of elements which are not seen either to coalesce or not to coalesce into unity. Error is always due to the acceptance of a problematic object as real or its rejection as unreal. Error mainly consists in confusing an object as it might be, so far as it is known to us, with the object as it is. When we mistake for a horse an animal (*viz*., a cow) which is moving behind a bush, we are confusing the moving animal as it might be, so far as it is known to us, with the animal as it is. Men would not fall into error if they refused to accept of reject an object without sufficient scrutiny. The only kind of object which the mind will accept and rest in is one which it thinks to be real, that is, one which it judges to be such as it is suggested to be.[16]

[14] John J. Toohey, S.J., "Reality and Truth," *The Philosophical Review*, v. 48, issue 5 (Sep., 1939), p, 494. Toohey says, "The elements of which we speak in the case of an unreality are not themselves unrealities, but their suggested coalesce is unreal.
[15] John J. Toohey, S.J., "Reality and Truth," *The Philosophical Review*, v. 48, issue 5 (Sep., 1939), p, 495.

The possibility of error is due to failing to exert sufficient scrutiny to the objects under suggestion. This can be a result of expediency in science. Often times we cannot wait until sufficient scrutiny has been accomplished. A need for a problematic object to be accepted, or rejected, precedes the amount of time necessary to fully scrutinize the object. Expediency must be weighed against certainty in our actions. Considering that certainty takes time, the degree of certainty of a judgment regarding a problematic object is balanced against the earlier, though uncertain, accomplishment of goals. A simple example of this may be space flight, it may take thousands of years to accurately, and with absolute certainty, develop the theories necessary to undertake space flight, but we may be willing to deal with the uncertainty of incomplete, or even problematic, theories to get into space sooner. Toohey also makes the point in "Reality and Truth", that while some philosophers claim that reality is the ultimate subject of every proposition, Toohey asserts that reality is the ultimate predicate of every judgment.[17]

One final note here is that in accordance with everything discussed above when we discuss the word unreal, we can only use this word in the realm of ideas, or argumentation. To say that something is unreal is to say that what was suggested of it does not coalesce into a unity, except in the instance of a problematic object. In the case of a problematic object, to say that it is unreal is a judgment rather than a logical necessity. While it could exist as suggested, however, it does not, would be the claim made in denying the realness of a problematic object. Only in being able to show that an

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[16] John J. Toohey, S.J., *Notes on Epistemology* (Ann Arbor, MI: Edwards Brothers, Inc, 1946). P. 9.
[17] John J. Toohey, S.J., *Notes on Epistemology* (Ann Arbor, MI: Edwards Brothers, Inc, 1946). P. 10. Unfortunately, the contents of the manuscript listed with unknown publication information and the 1946 version are very different. Where information was found that exactly corresponded between the manuscript and the 1946 version it was cited as being from the 1946 version. Else the manuscript was found superior and if there was a difference between the two sources the manuscript was cited as definitive.

object does necessarily exist, did necessarily exist, or will necessarily exist can we know with certainty of its existence. Only in knowing that an object cannot, could not, nor will not necessarily exist can we deny its existence with absolute certainty.

A Defense of Ontological Truth

There are those who deny the existence of a mind-independent reality. Common sense tells us to dismiss these comments as nonsense. In proposing that we can come to know things of the external, mind-independent reality around us it is first necessary to prove the existence of such a world. For to fail to do so, would put one in a position of establishing relationships on a logically contingent, rather than a necessary, basis.

In forming an argument one must already posses a mind. To use this mind and formulate an argument against the existence of a mind-independent reality, as will be shown, involves one in a contradiction. 1) The mind cannot create itself, for to create itself, the mind must have already existed. 2) Thus, the existence of a particular mind is dependent upon something prior. 3) The mind is dependent on the existence of a reality outside of itself within which to exist. 4) This reality must be one in which change is an element of its nature. 5) As such, the mind can only exist within a reality independent of its own existence and in which change is possible. Thus our own thoughts are dependent on an external reality, as described previously, in order for us to have them.

1) The mind cannot create itself. To say that the mind created itself would be a contradiction. The act of creating is an action, there is a cause and effect relationship asserted. For one thing to cause another, both the cause and the effect must exist as stated. In this case to say that the mind comes into being as a result of itself is

contradictory. A can cause B, but B cannot cause A. Our minds cannot even conceive of this act. How could a mind accomplish what it is impossible to conceive?

2) Our minds existence must be dependent upon the existence of something outside of itself. Our mind's existence is dependent upon other things. We may not have to know all of these things, but certain things must necessarily exist for the mind to exist. Our minds as an effect are the result of certain prior causes.

3) The mind is dependent upon a reality outside of itself. Since the mind cannot create itself, its existence, presupposed in arguing, must exist in a reality external to it. If the mind were to exist within the mind, then one would have to say it created itself, this being contradictory, as listed under 1) above.

4) The reality in which the mind exists must be one in which change is possible, in which change is a part of its nature. For the mind to come into being the reality in which it exists must be of a nature in which change is possible. To come into being from not being is change. By arguing and using a mind, that mind must have come into being a reality in which change is a part of its nature.

5) As such, the mind can only exist in a reality independent of its own existence and in which change is possible. For the mind to exist it must exist in a reality that possesses the properties of mind-independence and change. If one of these were absent, then the mind could not exist and one could not use a mind to argue the contrary.

One must also admit the existence of the mind in even formulating and engaging in argument. This mind cannot know everything, but must be capable of knowing things and in knowledge of certain things such as its own existence. Only under these conditions can any claim be made, and for argumentation to take place.

As concluded for argumentation to take place there must be a mind. For there to be a mind there must be a mind-independent reality, in which change is possible. To argue against this is a contradiction. One must use an element of a mind-independent reality, the mind, to argue against the existence of a mind-independent reality.

The existence of things within a mind-independent reality is as real as our minds are. To deny this is a contradiction. As pointed out earlier, for something to be ontologically true means, "An ontological truth is a reality which can be assented to or a reality which can be known."[18] Thus there is a mind-independent reality, in which the existence of things is independent of our knowing them. Our minds while definitely being elements of a mind-independent reality do not have to be the only things within this realm. In fact, they cannot be; there must be other things that are causes to our minds existence. Thus while we can say that there are things in a mind-independent reality, these things are ontological truths; we cannot say how many of them, only that it is greater than 3, the mind-independent reality itself included. The task of science, coupled with metaphysics is to discover these things, their natures and the relationships between things.

Other Minds

Common sense dictates that other minds exist. To deny such a thing, to the average person who interacts with others on a daily basis, is a matter that one would think no serious person would consider. However, it is a question that philosophers ponder. The very existence of language, as Wittgenstein asserts, is a proof of other minds. One could never come up with a private language, for one could never know if he was

[18] John J. Toohey, S.J., *Notes on epistemology* (Origin of manuscript unknown). P. 4-5.

following the rules of such a language. In addition, as Michael Levin points out in "Why We Believe in Other Minds" that this belief does not come into being from not being, but rather is present at an early age and prior to it there is no belief about other minds. He goes onto state that this property is the result of evolution. That those who did not believe in other minds were at a disadvantage to those who did and natural selection has to a large extent favored those who do believe in other minds. Now this does not prove of other minds, only that we do believe in other minds. Levin points out early in his piece that

> Let me prepare the way for my positive thesis by explaining why all traditional thinking that sets the problem as one of justified inference from the first-person case (i.e. all traditional thinking) must fail. The problem of other minds is normally posed in this way: on what basis do I *infer* that various organisms I observe are conscious, and is this inference *justified*? Each stressed word contains a hefty assumption which usually goes unchallenged and indeed unnoticed. First is the assumption that each individual, as a sort of information-processing atom, goes from non-belief to belief about the existence of other consciousnesses. Second is the assumption that the process by which the transition is effected is inference. Now, these two assumptions can both be true even if the inference involved is faulty; in that case nobody would *know* of other minds, even though there would now be some understanding of the process which creates *belief* in other minds. However, since such a process that culminates in unwarranted belief would be in vain and unlikely – we all suppose pre-theoretically that we *know* there are other minds – philosophers write as if our retention of the belief depends on the soundness of inference. In all this, the purely causal question, "By what process – reasonable or not – do we come to believe in other minds?" is ignored.[19]

The odd thing is that one could not productively even discuss the absence of minds. For to do so would be to argue with something similar to a wall, while one might be fooled into believing that a wall were rational, it would be fallacious to think that the argument could change as a result of the argument and thus be non-productive and thus be an evolutionary disadvantage. In essence Levin's argument assumes that evolutionary pressures tend to favor those who believe in other minds.

[19] Michael E. Levin, "Why We Believe in Other Minds," *Philosophy and Phenomenological Research, v 22, Issue 3* (March, 1984). P. 343.

Can We Obtain Knowledge About the Mind-Independent Reality?

Having come to the conclusion that there is a mind-independent reality, the claims of idealist are put to rest. There must be a mind-independent reality in which our minds exist. Thus those who claim that there is no mind-independent reality external to the mind are, of course, in contradiction. There are those who could claim that while there may well be a mind-independent reality, we cannot come to know things about it. As pointed out earlier, we can know things of a mind-independent reality. We can know of at least three things from this previous argument. 1) That our minds do exist. 2) That a reality external to our minds and independent of them exist. And 3) that there must exit other things from our minds, since our minds existence, as a contingent entity must have been caused by something other than itself. An indirect proof against the claim that we cannot know things about the mind-independent reality will be put forward. For in making such a claim, those who make the claim must already presuppose an ability to know things about this mind-independent external reality. Those who say that we cannot know things about the mind-independent reality, are, themselves, saying that the products of the mind (ideas) do not stand in any truthful relation to a mind-independent reality. He cannot make the assertion that no relationship exists, while actually asserting knowledge of a truthful relationship between the products of the mind and this mind-independent reality.

As Father Toohey points out in *Reality and Truth*, "Error mainly consists in confusing an object as it might be, so far as it is known to us, with the object as it is."[20] In denying the truthful relationship between the mind and the external mind-independent reality, one must, for it to be true, already presuppose knowledge about the mind-

[20] John J. Toohey, "Reality and Truth," *The Philosophical Review, v. 48, issue 5* (Sep., 1939), p, 495.

independent reality. His claim is nothing other than a claim that supposes a relationship between the two objects is false. In other words, this is a knowledge claim about the external mind-independent reality. An example, if I were to see an animal in a bush and call it a horse, no one could make the certain claim that I was in error unless they had a claim to know what the animal actually was, say a cow rather than a horse. To deny that one knows that the animal is a cow rather than a horse, or to deny that one has some knowledge about the animal that presupposes it is not a horse is to make a claim from ignorance. The same thing applies to those who claim that we cannot know things about the mind-independent reality. In doing so, for it to be potentially truthful, one has to assert knowledge of the nature of both the mind and the mind-independent reality, and claim that knowledge does not coalesce from the natures of them. This is to assert knowledge of the mind-independent reality and thus involves one in a contradiction.

Those who say that while there may be truthful relations between the mind's products and reality, but we don't know of any are arguing purely from a point of ignorance. The existences of such relations are independent of X, Y, or Z's knowing them. Thus the claim that X does not know of these relations is something that can be dismissed as ignorance and nothing more.

By demonstrating the impossibility of there not being truthful relationships between our minds and a mind-independent reality, then it leaves nothing but the case that there are in terms of informed discussion. They are not only possible but they are the only rational possibility. This does not in anyway make the claim that we know, or can know everything about the mind-independent reality, but that knowledge is possible and

does exist to a certain extent, but not a universal extent in knowing everything about everything. We can't know everything, but our knowledge does exceed nothing.

Truths and Mind-independent reality

Science, as will be discussed later, is the discovery of things, their natures and the relationships between things. Done correctly science leads to an increase in the stock of knowledge, by creating new ideas that are true, assented to, and assented to for a good reason, regarding the existence of things, their natures and/or the relationships between existing things. To perform science there must be a stock of things, the mind, and nature (mind-independent reality) about which we can use as subject matter for science. The study of these types of things belongs to ontology, ontology as a part of metaphysics, which deals with what types of things exist and how they exist. The previous discussion has proven at least two elements that do in fact exist that will be the subject matter of our further discussion, the mind-dependent world, and the mind-independent (and changing) reality, with things in it. It has also been shown that we can know things about these two realms. Knowing that there are mind-independent and mind-dependent realities, the next task is to prove the process by which knowledge of these things is obtained. This is the task of the branch on philosophy known as epistemology.

Assention

The discussion here will be short, since there is little controversy that knowledge requires one to assent to a proposition. One could not possibly know what one fails to assent too. As Fr. John J. Toohey S.J. points out in *Notes on Epistemology* assent is the mental assertion of a reality or of something taken for a reality. Thus while one may assert to a falsehood, assertion is a necessary, but not sufficient condition for knowledge.

In discussing knowledge, it would seem incomplete for example to discuss knowledge as merely being the assertion of something that is true. If this were the case then chance could be an element to the existence of knowledge about future events. I could say the next roll of the dice in a crap game is going to come up a 7. In doing so, do I really know that fact, provided the dice roll does come up a seven. Assuming I have not loaded the dice, can one really say that I knew this? That will lead us to the next discussion on the conditions of knowledge, that *p* must have a good reason for asserting that *x*. At best one could assent to a reality, but only incidentally.

What Constitutes a Position to Know That *p:* Kant

The Kantian distinctions, a priori, a posteriori, analytic and synthetic refer to the formation of logical truths. Universals and relationships ontologically exist independent of our knowing them, logical truths, which fit the Kantian distinctions and are also described by them, result from our knowing them. How we know certain truths are described, or categorized by Kant's distinctions. The existence or non-existence of logic does not make something true or untrue. Logic, or more to the point reason, is a gift that enables us to discover truths; it does not make them true or untrue. The correspondence of a proposition to reality is the task of reason. Reason is not a necessary element of ontological truth, but rather a necessary element for the discovery of logical truths.

The Analytic/Synthetic and A Priori/A Posteriori Distinctions.

Come then, let us enter into each matter, discussing it so it can be grasped and understood, for it seems well said that educated people try for such certainty as the matter itself allows. – Boethius' De Trinitate[21]

[21] As cited in St. Thomas Aquinas, "On Natural Science, Mathematics and Metaphysics," *Selected Philosophical Writings*, trans. Timothy McDermott (Oxford: Oxford University press, 1993) p. 1-2.

Immanuel Kant's philosophy gives us an important set of distinctions regarding propositions. Propositions may be regarded in a two-fold manner. Either a proposition is analytic or synthetic on the one hand and either a priori or a posteriori on the other. Analytic propositions are those in which "the means of formal logic are sufficient in order to find out whether they are true or not; otherwise they are synthetic."[22] This is not to say that logic is not necessary in order for a proposition to be synthetic, rather that formal logic is necessary, but not sufficient in order to find out whether they are true or not. On the other hand, "propositions are a posteriori whenever observations are necessary in order to establish their truth or at least confirm them. If observations are not necessary, then propositions are a priori."[23]

The tricky part to these distinctions is what is meant by observation? Karl Popper puts this problem as follows,

> The older positivists wished to admit, as scientific or legitimate, only those *concepts* (or notions or ideas) which were, as they put it, 'derived from experience'; those concepts, that is, which they believed to be logically reducible to elements of sense-experience, such as sensations (or sense-data), impressions, perceptions, visual or auditory memories, and so forth. Modern positivists are apt to see more clearly that science is not a system of concepts, but rather a system of statements.[*1] Accordingly, they wish to admit, as scientific or legitimate, only those statements which are reducible to elementary (or 'atomic') statements of experience—to 'judgements of perception' or 'atomic propositions' or protocol-sentences' or what not.[*2] It is clear that the implied criterion of demarcation is identical with the demand for an inductive logic.

The distinction made regarding what is observation is crucial. Is observation purely those experiences with external causes? I contend this is so and it is due to a

[22] Hans-Hermann Hoppe, *Economic Science and the Austrian Method* (Auburn, Al.: Ludwig von Mises Institute, 1995), p. 17.
[23] Hans-Hermann Hoppe, *Economic Science and the Austrian Method* (Auburn, Al.: Ludwig von Mises Institute, 1995), p. 17-18.

natural distinction regarding the nature of different types of phenomena. Experience can incorporate both the physical, through sense perception, and the mental through reflection. The natures of the two objects are distinctly different and thus, as follows from them, the methods of acquiring knowledge of them and the nature of such knowledge differ.

To explain this, the way in which the mind forms ideas is of importance. Fr. John Toohey in *Notes on Epistemology* defines various ideas in relation to their subject matter.

> Apprehension is an act of the mind which merely represents an object and does not involve in itself a mental assertion. For example; the act of the mind which represents 'house', or 'water', or 'America' is an apprehension. When apprehension is viewed, not as an act, but as representing an object, it is called an Idea, Concept, or Notion.
>
> The material object of a cognitive act is the thing or things which are represented or attained by the act, as they are in themselves, independently of the mind's contemplation of them.
>
> The formal object of a cognitive act is that which is explicitly represented or attained by the act.
>
> The material object of apprehension is the thing or things which are apprehended, as they are in themselves, independently of the minds contemplation of them.
>
> The formal object of apprehension is that aspect of the material object which is explicitly represented by the apprehension.[24]

Ideas in our minds are not the same thing as the object represented. However, they are derived from the object considered. Fr. Toohey then goes on to distinguish different types of ideas.

> A direct idea is an idea which represents something outside the mind; e.g., the idea of a tree.
>
> A reflex idea is an idea which represents something inside the mind; e.g., the idea of an abstraction.
>
> Reflection is an act of the mind by which it turns to contemplate its own acts.
>
> Psychological refection is an act of the mind by which it turns to contemplate its own acts so far as they are modifications of the soul.
>
> Ontological reflection is an act of the mind by which it turns to contemplate its own acts so far as they are representations, that is, so far as they represent an object.
>
> As the portraits of a painter have two aspects, viz., they are colored, and they are representations of persons, so an apprehension has two aspects, viz., it is an act of the mind, and it is a representation of an object. [25]

[24] John J. Toohey, S.J., *Notes on Epistemology* (Ann Arbor, MI: Edwards Brothers, Inc, 1946). P. 72.
[25] John J. Toohey, S.J., *Notes on epistemology* (Origin of manuscript unknown). P. 1.

By reflecting on ideas generated through the senses, our link to the external mind-independent world, we reflect ontologically. In reflecting on our own mental acts we reflect psychologically. It has been pointed out that through the introspective act (psychological reflection) that one could not come to know everything about one's self. While this is true, one would always have to consider the act of reflecting on everything else as a infinite regress to obtain total knowledge, it is of no real significance in making the claim that one can come to know some things about one's self through the reflective (or introspective) process. One can also come to know things about the mind-independent reality through such a process. Geometry, optics and other sciences about mind-independent phenomena are done in the same manner. A simple example is the ball that is red and non-red at the same time in the same respect. We can through ontological introspection categorically deny the existence of such a ball and do not have to search the globe and universe for such a ball. These propositions as we will come to see must in part have a synthetic a priori nature. While we may come to know of a ball, red, and non-red through sense data. We can only deny the unity of these aspects of a ball at one point in time through the ontological reflective process.

The nature of sense data is that its extent is limited in time and or space. We cannot form knowledge about universals through sense data alone. For example, take the issue of the existence of a big foot. We can define big foot as a creature of superhuman size, covered in log hair, with feet too big to be human. We can then say this big foot trounces through forests and lives in isolation. If we fail to sense such a thing does that mean it does not exist? The answer is no. There are plenty of things that exist and we don't know of them. Science is the search for knowledge of things we do not know. In

addition, to rule out a big foot we would have to observe every square inch of land all over the globe at the same time to know that no big foots existed. Even if this were possible, that would only rule out a big foot that existed at that particular moment. It would in no way disprove that a big foot did exist, or that a big foot would ever exist.

To disprove anything we must be able through ontological reflection to deny the possibility that all aspects of an object, in this case a big foot, could form a unity. In other words through ontological reflection we would have to discover that one aspect of a big foot, or any other object, precludes some other aspect of it from forming a unity in the object. In the case of the ball that is red and non-red all over at the same time in the same respect this can be accomplished. Object that we cannot discern whether they come to form a unity or not are a third class called problematic objects. These types of objects are asserted to or not based on judgment. The propositions regarding their acceptance are not knowledge; they can only be true incidentally.

Relationship Between Kant's Box and Thomistic Idea of Reflection.

Earlier in this chapter a discussion on the different categories of knowledge was promised. The discussion above will be related to Kant's distinction. Once this has been done, using Kant, we can discuss the extent and validation methods for truths. These characteristics will be dependent upon the object under consideration. Direct ideas are attainable when observed through experience, or sense data, with sensation as the impetus for an apprehension. Direct ideas will be considered as a posteriori propositions.

Reflexive ideas will be considered to be a priori; they are however reflections derived from reality, either mind-dependent or mind-independent. The psychological reflection being one in which the material object of the idea is an act of the mind so far as

they are modifications of the soul. In acting, human beings follow a pattern, that pattern is based on the relieving of some uneasiness through the accomplishment of a goal. Human action implies the use of scarce means, including time and their own physical bodies, with alternative uses, through a perceived causality to accomplish given ends. By reflecting onto our own acts whether they be cognitive, or otherwise, one can discover this thing called purposeful action.

On the other hand by reflecting on direct ideas, one can, through thought regarding the possibilities of different aspects in things derive ideas regarding the impossibility of things. As such, if we rule out every possibility but save one, then it must exist in that matter, if it is to exist at all. By comparing direct ideas with these reflexive ones we can identify things, and classify them as likes or dislikes to the reflexive ideas.

The fact that a ball is an object spherical in shape, which is apprehended by the mind through observation, then examined through ontological reflection to be found to have a potential of being red, can be compared to the apprehension of an object. If the object meets this criterion it is found to be a red ball. We can think of many different variations of balls. We cannot rule out red balls, or purple, green, blue, yellow etc. . . . We cannot rule out balls that may be multi colored in that the ball may have different areas of different color. But we can, however, rule out one that is red and non-red all over at the same time in the same respect. We do this by reflecting on what red, non-red, all over, and a ball are and acknowledging that these properties can not form a unity.

This type of reflection can determine what elements can be brought into unity, however, if one of the elements suggested of an object is existence them we can run into a problem. “This may be called a *problematic object*, which may be defined as a

suggested coalescence of elements which are seen either to coalesce or not to coalesce into unity. Error is always due to the acceptance of a problematic as or to its rejection as unreal. Error mainly consists in confusing an object as it might be, so far as it is known to us, with the object as it is."[26]

While it may be necessarily true that a ball could be red, this merely affirms the possibility of the attributes red and a ball coalescing into a unity. The added claim that such a ball exists independent of the mind is a separate claim, for since the existence of such a ball, in a mind-independent reality, is contingent upon time and place. We can call the problem as to the existence of such a problematic object an identification problem. One must, through sense data compare the apprehension of a red ball to an object observed in the mind-independent reality.

In comparing elements of a reality (mind-dependent, or mind-independent) to ideas, these distinctions are made about logical truth claims. A logical truth claim is a statement about what exists or did exist, how it exists, its nature, or relationships between things. I could for example make the statement A is B. Now if by definition an A is a non-B; thus a B is a non-A, this statement is false. An A cannot exist as a B. However, knowing this is false, I could say that a person holds the view that an A is a B, knowing fully well the same definition stated previously for A and B. Is this statement possible? The answer is yes, since what is being asserted is not the existence of an A that is also a B, but rather that this person holds this idea. What is being asserted is that this idea exists in that person. Regardless of the fact, that this person is committing an error by holding this view.

[26] John J. Toohey, S.J., "Reality and Truth," *The Philosophical Review*, v. 48, issue 5 (Sep., 1939), p, 495

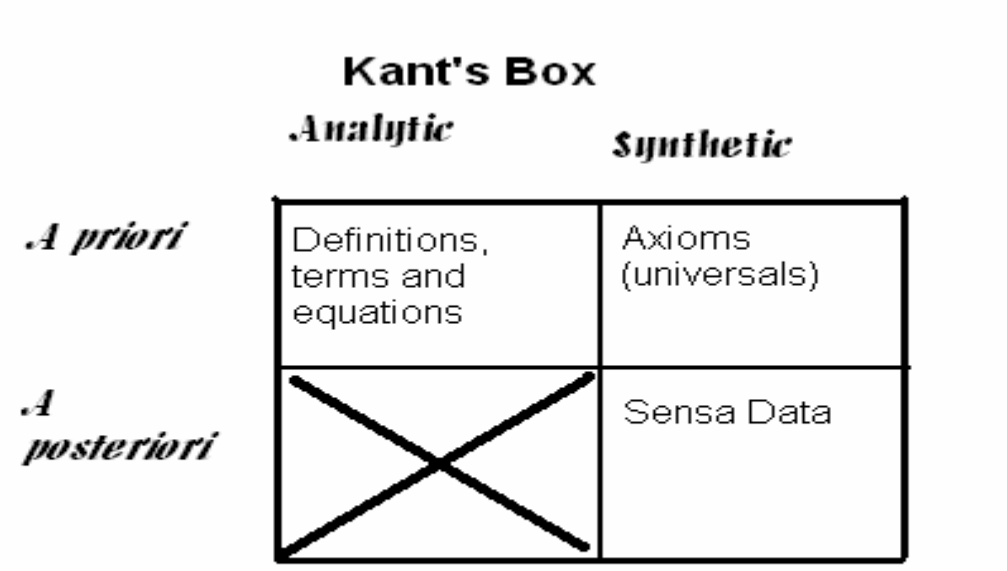
This brings us to the mythical phoenix. While it is true to state, for example, that there was a mythical concept of the phoenix and that people believed this bird existed, when there is no evidence apart from myths that the thing actually existed. It is another to state that the Phoenix, as a material object, caused some calamity. Instead, we could say that people's belief in this mythical bird, did result in them acting in a certain way at certain times. We could even attribute this belief in the phoenix as a beginning to some cultural view or ritual. The phoenix, as a bird that rises up from its own ashes, is separate from the belief that certain individuals held that it existed as a material object. The belief and its relationship to certain actions are separate from the non-existent relationship between a phoenix and some calamity. The statement concerning a phoenix, as a material object, and its relationship between some calamity is a logical fallacy, even if it is believed. The relationship between some person or people's belief in the phoenix and certain actions or rituals would be another matter. The second proposition could very well be true or untrue, while the first is clearly untrue.[27]

Kant's Box

Acknowledging Kant's distinction regarding the formation of logical truths, separate from the creation of ontological truths, we then form the classification system for logical truths. The way in which Kant performs this task can be exemplified through the use of Kant's Box. Kant in categorizing logical truths, I have added logical, does so in a two-fold way. Each logical truth is categorized as analytic or synthetic and as either *a priori* or *a posteriori*. Below is Kant's Box in which each type of proposition is categorized, examples included.

[27] Throughout this discussion it is assumed that we could know with absolute truth that the phoenix as defined never existed, all problems with such a statement acknowledged.

FIGURE 2-1



In the box above are 4 different types of logical truths, they are classified as either analytic or synthetic and either *a priori* or *a posteriori*. Three of the boxes above have elements within them. For example, the analytic *a priori* box contains the set of all-true definitions, terms, and equations that are also logical truths. One of the boxes, marked by a large **X** is empty.

Starting from right to left the various truthful propositions are analytic a priori, synthetic a priori, analytic a posteriori, and synthetic a posteriori. Analytic a priori propositions are those in which the means of formal logic are sufficient to determine if a proposition is true or false and for which observation is not necessary. These are logical truths that can be learnt through logic in the absence of observation. It is held by a

number of philosophers that these propositions are non-operational. They do not convey new or accurate knowledge about the real, or mind-independent, world.[28]

The second category, which contains an X in its box, is that of the analytic a posteriori proposition. An analytic a posteriori proposition is one in which logic is sufficient, and in which observation is necessary to determine if it is true or false. The contents of this box are of no concern for the discussion.

The third box, the synthetic a posteriori, contains sense data. These are propositions in which formal logic is necessary, but not sufficient and in which observation is necessary in order to determine if a proposition is true or false. These propositions are operational, in that they do convey information about the real world. The extent of such knowledge is limited in time and space. While it may be true here it may not be true elsewhere. While it is true now, it may not be true always.

The final categorization, the synthetic a priori, is the most controversial within the epistemological field. A synthetic a *priori* statement is one in which the means of formal logic are necessary, but not sufficient, and observation is not necessary in determining if a proposition is true or false. A synthetic *a priori* proposition is learned with the aid of logic, but the absence of observation. How can this be?

As was put forward earlier in greater detail it is through the being of what one is speculating on and the reflective act, through which one can gain knowledge of these propositions. In Thomistic fashion it is maintained that through examining our own actions, natures and apprehensions, such as direct ideas, and reflex ideas that we can

[28] It is not my job to quibble here as to whether or not these propositions are arbitrary, or true only by definition. I am willing to accept this claim, as it in no way detracts from my purpose, nor puts my ideas at an advantage. The intent of this paper is not to delve into this question of the non-operational nature of

obtain axiomatic knowledge about man's actions and the world around him. Although I have never seen this in any writings, one might also be able to speculate on things in a mind-independent reality in the same manner. While I am human, I am also real, I am extended in time and space, and thus I could understand what it means to be real and to extended in time and space, and thus discover necessary statements related to those things. Necessary statements of a synthetic nature must be the foundation for any true pure science. The absence of which results in knowledge only incidentally.

In determining that suggested combinations of elements or attributes do coalesce into a unity man can determine the 'reality' of things. When the suggested combination of elements or attributes is known to not coalesce into a unity we can deny the 'reality', or call a thing "unreal'. When we cannot ascertain whether a combination of elements or attributes can coalesce into a unity we call these things problematic objects. We do this through either ontological reflection, in the case of mind-independent objects, or through psychological reflection concerning our own, mind-dependent, actions. In doing so, we can come to rule out certain suggested combinations of elements. We can call the statements derived from such reflection synthetic a priori propositions.[29]

Knowledge of this type is operational. It does convey information about the real world. The extent of this knowledge is universal. It is true now and always, here and anywhere else. These logical truths are necessary in the philosopher's language. The

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analytic a priori propositions, but rather to question there use in the acquisition of truthful scientific knowledge.

[29] To be classified as synthetic *a priori* a proposition must be true, assented to, and assented to for a good reason. In the case of synthetic *a priori* propositions, through reflection that shows something must be the case.

truthfulness of such statements provided they are learned in the correct fashion, are independent of time and or place.[30]

Necessary/Contingent Distinction and the Synthetic A Priori

> Contingency- 1. (of entities) The property of not having to exist. 2. (of events) The property of not having to occur. 3. (of propositions) The property of not having to be true, or of risking the possibility of being false.[31]
> Necessary- A proposition is said to be necessarily true, or to express a logically necessary truth, iff the denial of that proposition would involve a self-contradiction, a proposition which happens to be contingent truth, is one which could nevertheless be denied, or asserted, without self-contradiction.[32]

> Logical empiricists, however, have doubted whether necessary truths can yield fresh information about the world, on the ground that they are logically analytic, or tautological. Thus it has been thought that most or even all of our experience and knowledge is of a contingent kind. ... In the philosophical novel, La Nausee, and elsewhere, Sarte appeared to lament the contingency of all existence."[33]

Necessary truths that tell us fresh information must exist. To deny them a necessary statement must be used in order to make the claim that only contingent statements can be operational (synthetic). This claim about necessary statements is itself a self-contradiction. A useful necessary statement must be used in order to deny the existence of useful necessary statements. If necessary truths are tautological, and only analytic, then this claim must also be a tautology and analytic.

In other words, the existence of necessary truths is a true necessary statement. By stating that necessary truths exist one is not involved in a contradiction. To deny necessary truths one is involved in a performative contradiction (using something to deny its existence). Any statement regarding the existence, or non-existence of necessary truths

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[30] This relates back to our definition of what it means to know. For X to know *p* i) *p* must be true, ii) X must assent to that *p* and X must be a position to know that *p*.

[31] Antony Flew, *A Dictionary of Philosophy*, Rev. 2nd ed., (New York: St. Martin's Press, 1984), p. 74.

[32] Antony Flew, *A Dictionary of Philosophy*, Rev. 2nd ed., (New York: St. Martin's Press, 1984), p. 241.

[33] Antony Flew, *A Dictionary of Philosophy*, *Rev. 2nd ed*. (New York: St. Martin's Press, 1984), pp. 241-42.

must, be an operational concept and thus not vacuous or arbitrary. It must tell us something about reality, thus being operational. When one states, there are no necessary truths, only contingent ones, one is claiming something about reality and the relationship between necessary truths and reality. Thus, if the opposite case is true, then it must also posses the properties claimed by its negation in this case. One who denies the existence of necessary truths, as truths, which tell us about reality, is invoking a necessary statement, if it could possibly be true. They are, in fact, telling us the exact opposite when they try to do so. The utterance that there are no necessary truths that reveal fresh information about reality, is and must be considered non-sense. What else can one make of a statement that claims that A does not exist, while using an A to express this claim?

In order to both understand and grasp the world, we must already presuppose that we can both understand and grasp a mind independent reality in order to discuss the topic. Certitude is an important concept in science. Certainty is an end for science if we could be certain of everything, we would have no need for scientific research, except as a hobby. Certitude relates to epistemology in the following way, according to Fr. John Toohey S.J.

> Certitude is a firm assent of the mind to a perceived reality.
>
> . . . The thesis is laid down in order to determine the real definition of the word "certitude." Unless we have a clear idea what is meant by the word "certitude," our discussions in Epistemology will be fruitless.
>
> The word "firm" in the definition signifies that assent is unwavering.
>
> "Reality" means that what is assented to does not depend upon the mind's thought about it for being what it is.
>
> By "perceived reality" we mean a reality which has been brought home to the mind by adequate evidence or proof.
>
> We have intrinsic evidence of a reality by the immediate perceptions of the mind or of the senses or by inferences from those perceptions.

> We have extrinsic evidence of a reality by the testimony of rational beings; thus we have extrinsic evidence of the existence of Napoleon and of Australia.
>
> We have direct proof of a reality by reasoning from immediate perceptions of the mind or of the senses or from testimony of rational beings or from all combined. Thus, we have direct proof of many theorems in geometry and of the motion of the earth around the sun.
>
> We have indirect proof of the reality of a thing by showing that to suppose it to be unreal would involve a person in a contradiction.
>
> N.R. All proof is evidence, but not all evidence is proof. Proving means making evident what is not evident.[34]

Synthetic a posteriori propositions are proven using direct proof, for example the fact that there is writing on this page. One can come to know this by reasoning from direct perception of the senses. Logic is necessary, but not sufficient and one needs observation. One must see the page and relate what is on the page to writing and this page. In doing so, we can know at particular instances that there is writing on this page. Relying on extrinsic evidence, for the reader, he can come to know that this was not always the case. I can honestly relate that there was not always writing on this page.

The use of indirect proofs is the key to our understanding the relationship between the mind and mind-independent reality. The mind and mind-independent reality must both be real; otherwise to discuss any sort of relationship between them in a serious manner would be absurd.

When one claims any such relationship, especially that there is no relationship, he has already admitted the existence of both. To deny the existence of one or the other (the mind and an objective mind-independent reality) and then to say that no relationship exists and that this proposition must be valid is to involve one's self in a contradiction.

[34] John J. Toohey, S.J., *Notes on epistemology* (Origin of manuscript unknown). P. 6.

The denial of synthetic a priori propositions, being necessary truths, derived through the psychological or ontological reflective act, and proven indirectly is a clear contradiction. For if we were to deny the existence of such a proposition, we would need one in order to do so. For example, the claim that there are no synthetic *a priori* truths, for it to be true, could not be inducted from experience. In order for it to be true, it too would have to be a synthetic *a priori* proposition, derived through the reflective act.

One could, argue, there might well be synthetic *a priori* propositions, but I don't know of any. This would be nothing more than an argument from ignorance. I've never experienced flight in a spaceship, but to say that there must not be space flight because I have never experienced it is not true.

Certitude is the end of science; however, between here and certitude, errors will be made. These errors are a problem for which certain skeptics have tried to justify skepticism. An example would be the defense of skepticism, which maintains that a skeptic would never assent to an error, since he would always be skeptical and never accept anything as certitude. As we have already discussed, the universal skeptic would be guilty of accepting certitude in that he should be skeptical of everything, this being certain. Being skeptical of everything would require certitude in that "we should be skeptical of everything." In addition Fr, John J. Toohey points out, "That system which is immune from error should be adopted. But universal skepticism is immune from error. Therefore universal skepticism should be adopted." This is an argument that since a universal skepticism is immune from error, i.e., never assents to what is false, that it should be adopted. This argument and others like them are refuted by reason on the grounds that while a skeptic may never assent to a falsehood, such as a false theory or

event, universal skepticism itself contains error in its doctrine. Namely those pointed out earlier in the form of contradictions involving the lack of skepticism's applicability to itself and the indirect proof that we can know of things, their natures and the relationships between them.[35]

Universals and Their Relationship to Reality

The existence of universals and their relationship to the world of nature is a question that has important implications to science and thus also to the history of science and the history of economic thought. The main views regarding universals fall into many groupings, the main grouping into which philosophers have discussed universals involve the Nominalists, the conceptualist, the ultra realist, and the moderate realist positions. The argument here falls with the moderate realist, universals exist not in the external mind-independent reality, but are extracted from that reality, either through ontological, or psychological reflection on experience from reality, mind-dependent, or mind-independent.

From the lengthy discussion above all axioms must be necessary propositions. It is true that all men must act, it is an ontological truth. The proposition that all men must act is contingent on men existing. Only a rational being can hold a proposition, as such, if the proposition exists there must be a rational being who holds it. As such, while the statement there are actually being human beings is contingent, the nature of a human being is not contingent. If there are humans, then they will act. This is a contingent statement. However, All men must act is true now, then and till the end of time. Acting is a part of being human; it follows from rationality and existence in a world of scarcity, a

[35] John J. Toohey, S.J., *Notes on epistemology* (Origin of manuscript unknown). P. 20-28.

world that is extended in time and space, and thus of limited means relative to virtually limitless wants.

To put this another way, ‘if-then’ statements may be both contingent, and necessary. For example, to say if a thing is a ball, then it may not be both red and non-red all over at the same time in the same respect. This statement is the result of ontological reflection. We know what red, non-red, a ball, all over and at the same time are, these elements do not coalesce into a unity, therefore, it is necessarily true. This ‘if, then’ statement may also be put forward as No ball may be both red and non-red all over at the same time in the same respect, or there are no balls that are both red and non-red all over at the same time in the same respect.

On the other hand, when dealing with problematic objects, such as hypothesis, these propositions are not known and thus are not categorized in the knowledge distinction box. Statements such as big foot does not exist, or if a big foot exists we would have evidence of him are judgments rather than knowledge. As such, when philosophers call these statements contingent they are not referring to them as knowledge, but rather judgments. The coalescence of an 8 foot tall, two legged animal covered in hair that trounces through North American forest, in combination with the words that exists independently of our minds is neither negated nor proven as being a unity. We do not know. Thus the statement if a big foot exist then we would have evidence of him is false.

Another example, if sodium and chloride are combined under the right conditions then salt will be the result. This statement is a hypothesis. For one thing we would have to know the right conditions with absolute certainty, to know this we could not know it

from direct experience, but rather through an indirect proof derived from a set of axioms regarding sodium, chlorine and the other conditions which affect them. We may not know all of them. Thus it is possible that under certain conditions that we do not know, that if we follow all the accepted steps to forming salt from chlorine and sodium that salt will not form. This proposition is hypothetical; it is contingent on our knowledge with absolute certainty, a certainty we do not posses because we do not know the first principles regarding these chemical reactions or all of the theories derived from them.

With the hypothetical statements, we cannot reword them in a manner that does not include the words hypothetically or possibly and for them to be true. For example, it is possible to combine chlorine and sodium under a set of conditions in a way that produces salt. These problematic statements are not knowledge, and thus not considered analytic, or synthetic, nor *a priori* or *a* posterior*i*.

While this definition of knowledge as certain may seem to violate the principle that words used by philosophers must coincide with their common usage, it is not a violation. In fact, the common usage of the word knowledge has many different facets. In this case, we are defining and discussing scientific knowledge. While it might be fine to say John knows that the next role of a fair pair of dice are going to come up a seven, the word knowledge would not be applicable if we were to find out that john is a well respected statistician. In this sense John does not know as a scientist that the roll will be a seven. In fact he would have to say he does not know that the roll will come up a seven. He could say I know that if the die were rolled an infinite number of times that the combinations that make up a roll of seven will come up more than any other total.

The word is being used differently when we discuss scientific knowledge and the common use of the word would differ based on the subject the word is being related to. Scientific knowledge is different than forms of judgment. To know something in a scientific sense, certainty in its truthfulness is a part of the definition. The previous use of the word knowledge is the only definition of knowledge that conforms to the proper definition of science as the discovery of things, their natures, and the relationships between things. For a thing to be discovered, it must exist as stated. To discover its nature, we must describe its characteristics as they indeed are. And finally, to discover relationships between things, the relationship must exist as stated.

This brings us to another important issue, the mind-body problem. The following is from Antony Flew,

> The philosophical problem of how the mind is related to the body, and what properties, functions, and occurrences should be regarded as, respectively, mental or physical. This problem is central to both the philosophy of mind and the philosophy of psychology.
>
> Both its prominence in modern philosophy and the established ways of representing it are primarily due to Descartes. Systematic doubt led him to conclude that the sole irrefragable certainty must be his own immediate consciousness as an incorporeal substance. The essence of this substance is to think, which in Descartes' made to-measure sense, embraces all (but not only) modes of self-consciousness. Besides such thinking he recognized also material substances. The problem thus comes to be conceived as that of the relations, between consciousness and stuff. Although Descartes was inclined to believe that his two sorts of substance must be totally different to affect each other, he nevertheless settled for the idea that two-way causal interactions do occur--in the pineal gland in the brain.
>
> Dissatisfaction with this account soon led to alternative theories. For example, Malebranche suggested occasionalism (according to which God is the sole causal agent of the systematic correlation of mind with body, while each item in each pair is only the occasion of the other). Another theory was epiphenomenalism (according to which mental occurrences are exclusively effects, never causes, of physical changes in the body). Occasionalism in its religious form may regard the non-causal correlations between the physical and the mental as involving a divinely

> "pre-established harmony" (*see* Leibniz). Psychophysical parallelism also recognizes such non-causal correlations and denies interaction, but it avoids theological speculation. Epiphenomenalism is most happily illustrated by the analogies of phosphorescence on water or "the halo on the saint" (C.J. Ducasse). Spinoza argued that the mental and the physical are simply two aspects of the underlying reality, God or Nature; while in our time P.F. Strawson contends that it is the concept of the person that is fundamental, and to which both mental and physical predicates properly attach.
>
> Berkeley and other idealists contended that really there is no causation either way, because there is no such thing as matter (*see* idealism). Metaphysical behaviorists (*see* behaviorism) reached the same conclusion, from the opposite direction; for them consciousness is the misconception. In other monistic (but always in fact idealist) theories, mind and body have been presented as complex but differently constructed collections of entities of the same kind: these entities being ideas, or perceptions, or sense data (*see* monism). Most recently there have been powerful supporters for an identity theory, urging that being in a certain state of consciousness and being in a corresponding physical state just are the same: like --a favorite example-- the Morning Star and the Evening Star.
>
> Given the Cartesian criterion of the mental, it is self-contradictory to speak of unconscious mental processes. But in this century Freud and other psychologists have introduced an alternative or supplementary criterion, the purposive. A new philosophical classic such as Ryle's *The Concept of Mind* thus prefers to challenge the Cartesian framework rather than to attempt an answer to his questions (see Ryle). But Ryle's attempt at an analytical behaviorism does not succeed, or even claim to succeed, in reducing all consciousness to behavior. So, although the mental is no longer to be identified with the conscious, the old problem of the relation between that and stuff remains.[36]

Do thoughts exist in reality? Thoughts are the products of our minds. These minds exist; if they didn't then the question itself would be of no importance, along with science itself. If minds do not exist, then there is a serious contradiction in using one to contemplate the question of their existence. Ideas exist just as a train or a chair exists. They are all a part of reality as a whole.[37] The distinction between ideas and physical objects is about the nature of their existence. While both exist, they do have different

[36] Antony Flew, *A Dictionary of philosophy, Revised Second Edition* (New York: St. Martin's Press, 1984). Pp. 232-33.
[37] As defined earlier by Father Toohey.

natures. A train is both extended in time and space and independent of the mind; ideas, however, are clearly dependent on the mind. This common sensual fact is alluded to in Aristotle and Aquinas.

> . . . Different kinds of things produce in different ways, those on a higher level producing in a more interior way.
>
> The lowest level of all is that of non-living bodies, in which production is only possible when one body acts on another. . . . So the highest, most perfect level of life is that of the intellect, for intellect can reflect upon itself and understand itself. But here too there are different levels. The human mind, even though it can come to know self-awareness, must still start by knowing outside things, and they can't be understood without sense-images . . .
>
> When I say 'the idea in the mind' I am talking of what is conceived in the mind by the mind out of the thing it is understanding. In us this isn't the thing understood itself, nor is it our own minds substance, but sort of representation conceived by the mind out of the thing it understands, and which is expressed externally in speech (so that the idea itself can be thought of as an interior word expressed by our exterior word). And that in us this idea we are talking of is not indeed the thing itself is clear from the fact that understanding things is not the same as understanding ideas, which mind does when it reflects on its own workings, And that the sciences of things differ from the science of intellectual ideas. And that in us this idea is not the mind itself is clear from the fact that for ideas to exist is nothing more or less than to be understood, whereas for us our minds existing differs from being understood. . . .[38]

This passage explains numerous ideas concerning the divisions between truth, knowledge and acceptance. The truth is the truth regardless of whether it is known by anyone. Our logical structures are our logical structures regardless of whether or not one has reflected upon them. Reason is a part of man's nature. It is a part of his nature, regardless of whether he knows this or not. For a thing to be known it must also be true,[39] ontologically for a thing to be true it is neither necessary nor sufficient that it be known.

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[38] St. Thomas Aquinas, "The Ladder of Being," in *Selected Philosophical Writings*, trans. Timothy McDermott (Oxford: Oxford University Press, 1993), p. 115-117.

[39] See footnote on the definition of knowledge

Once an ontological truth is known, then it is also a logical truth. St. Thomas Aquinas in the next quotation carries on this distinction.

> So he says: *Come*--exhorting us--*then*, given that Catholics believe in the unity of a three person God on the ground of undifferentiation, *let us enter into each matter*, that is, delve within, into the innermost principles of things, penetrating to the truth that lies veiled as it were and hidden; and do this in the proper way, which is why he adds; *discussing each so it can be grasped and understood*, that is, in such a way that it can be grasped and understood. He uses these two verbs since the way things are discussed must suit both the things and ourselves: the things if they are to be understood, ourselves if we are to grasp them.[40]

As St. Thomas Aquinas points out, the way in which things, the mind included, are discussed must both conform to the nature of the thing and the nature of man's logical processes. To do otherwise is to fail in one's investigation. Thus a thing may be true, but the way in which it is discussed must conform to man's nature as well. For something to be known, it must be true, in an ontological sense, and it must be discussed in a way that conforms to our own nature. Fr. John J. Toohey discusses these concepts of ontological truth as well as moral and logical truths.

In order to deny the existence of any true relationship between our minds and reality is to commit a contradiction. Before one can claim no relationship exists in a knowledgeable way he must know the natures of both the objects under consideration. He must assert that I know the mind and I know reality and the two do not posses natures in which the coalescence of elements between the minds ideas and the mind-independent

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[40] Note then that Aristotle says there are two proper uses of the term *being*: firstly, generally for whatever falls into one of Aristotle's ten basic categories of thing, and secondly for whatever makes a proposition true. These differ: in the second sense anything we can express in an affirmative proposition, however, unreal, is said to be; in this sense lacks and absences are, since we say that absences are opposed to presences, and blindness exists in an eye. But in the first sense only what is real is, so that in this sense blindness and such are not beings. St. Thomas Aquinas, "Natural Science, Mathematics, Metaphysics," in *Selected Philosophical Writings*, trans. Timothy McDermott (Oxford: Oxford University Press, 1993), p. 2-3. Italics in the original denoting Boethius' text. This work is commentary on Ch. 2 of Boethius' *De Trinitate*. This element is also seen in the statement by J.C. Maxwell regarding any science. “The first processes, therefore, in the effectual studies of the sciences, must be ones of simplification and reduction of

phenomena they try to explain is possible. In doing so, the claimant must already suppose a relationship. In that he can understand the nature of the mind-independent reality. If this is not a claim to a truthful relationship between the mind and the mind-independent reality then it is worthless.

For the claimant to know this, which he cannot possibly, he has to understand the mind-independent reality in relationship to his own mind. As pointed out earlier, the nature of scientific discussion must both conform to the nature of the thing being discussed and to our own nature. To do is to establish a relationship between the mind and the object discussed in this case the mind-independent reality. The fact that a mind-independent reality exists has been defended earlier, thus to say that a mind independent reality does not exist is already an error.

Science

If we are to grasp and understand it, science is the discovery of things, their natures and relationships between things. Anything else must be considered nonsense or at best pseudo-science, an imitation of science. False epistemologies and their corresponding methodologies have misled the sciences, especially the social sciences. The way science is done and the importance of its conclusions clearly follows from epistemology.

In order to discuss things in a meaningful way we must be correct in identifying what is (exists) and what isn't (does not exist). We must correctly identify the nature of things that do exist in order for a discussion to be meaningful, and only after these two things have been done can we then start to establish relationships between them.

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the results of previous investigations to a form in which the mind can grasp them." J.C. Maxwell on

Abstraction, done properly, and hypothesizing about what does or doesn't exist and what nature these things do or do not have are also important to theory. Before we can claim to know something such as A when combined with B produces C, we must know certain other things. In order to know that A and B in combination are the causes of this C, we must know that A exists and has some certain nature and that B and C also exist and posses certain natures. For a particular C we must know that some other cause of C was not present and that A and B were combined. If we misidentify A, B or C then the relationship is also untrue, for example, if A had turned out to be a D, then A and B would not be the cause of C, rather D and B would be the true cause of C, assuming no other cause of C were present.

In addition to the truthful nature of what is examined in science, one must be in a position to know the proposition examined by science. In order to *know* scientists must come to know various propositions in the manner laid out before. In identifying things and discussing their nature, scientist deal with things that we can know through direct proof, such as there is writing on this page. The extent of knowledge derived through direct proof is limited in time and space. These types of proposition are called synthetic a posteriori propositions.

Knowledge gained through indirect proof is necessary and universal. These types of truths fall into the synthetic a *priori* category. These types of truths may be gained through ontological reflection or psychological reflection. If in doing so, we can come to the conclusion that elements of a suggested object coalesce into unity then we know this object is a reality. The object can be the existence of a thing, its nature, or the

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Faraday's lines of force. From http://www.math.rutgers.edu/~oldstein/quote.html.

relationships between two known things. These things are said to exist externally to the mind or independently of the mind when performed through ontological reflection. These things are said to be mind-dependent when they come to be known through psychological reflection. These things may also be negated, in that the elements suggested of an object cannot coalesce into a unity. In this case we can come to know that a thing is not real, or does not exist as stated. Finally, we may not be able to ascertain whether the elements suggested of an object can, or cannot coalesce into a unity. In this case we have a problematic object. The acceptance of such propositions, is not knowledge, but rather relies on judgment, rather than proof.

The Kantian distinctions, alluded to earlier in this chapter, regarding propositions are necessary to discussing how propositions are grasped by the mind. For something to be true or untrue is for them to exist as stated at the time stated or to not exist, or to exist in a different matter from that stated. There is a separation here in which the distinctions regarding propositions refer to how propositions may be grasped. A synthetic a priori statement is one which may be grasped in the absence of observation and in which the means of formal logic are not sufficient in order to grasp it. The Kantian distinctions of analytic, synthetic, a priori and a posteriori refer to half of the puzzle. The way in which we grasp propositions is complimented by what makes something true or untrue. Propositions that describe the existence and true natures of things combined with true relationships among them are truthful statements. If something exists then it is an ontological or objective truth. If one assents to what exists in reality then it becomes a logical truth as well. This may seem a bit circular, but if a thing exists, has described properties, or if it forms a relationship with another thing then statements regarding these

concepts are true. These truthful statements can be grasped in different ways depending upon their natures.

Come then, let us enter into each matter, discussing it so it can be grasped and understood, for it seems well said that educated people try for such certainty as the matter itself allows. -- Boethius' De Trinitate[41]

Recalling St. Thomas Aquinas citing Boethius, in order to discuss something, it must be discussed in a manner in which it may be both grasped and understood. To discuss something in a way that it can be understood, we must discuss it in a way that suits the thing under discussion. It must also be discussed in accordance with our own natures so that it may be grasped. In discussing things in accordance with their own natures we discuss ontological truths, as logical and moral truths; only in this way can what is discussed be known. In discussing them in a way that they can be grasped we discuss them in accordance with our minds ability to come to the realization that they are true. This second aspect of discussion, and science if the discussion fits our definition, is by appealing to other experiences, sense experience for some, and introspective, or reflexive data for others. These categories fit in well with the Kantian knowledge distinctions. Through Kant we can grasp different categories of propositions through different means. In Kant we also can discuss the extent and validity of various categories of knowledge and relate them to scientific pursuits from an epistemological and metaphysical standpoint.

The Relationship Between Universals and Reality

There are those who assert that the relationship between universal statements and reality are non-existent, that universals are either meaningless, or subjective. An attempt

will be made to dismiss these charges and to establish the firm foundation under which science, especially the social sciences, can be based. This foundation is one which affirms our abilities as human beings to both know reality and to universalize this knowledge, specifically in the social sciences, in a way that is neither meaningless, nor subjective. Before one can embark on such a task, a discussion regarding epistemology must be undertaken in order that we may ground the universal concept firmly to reality.

As we have discussed earlier, it is a necessary truth that man can discover ontological truth regarding both things and their natures. The proof for this is an indirect proof. If one makes the claim that man is unable to discover the existence of things and the natures to these things, one is making a claim about the truthful relationship between man and a mind-independent reality, or the world of reality. This claim involves one in a contradiction. The claim that no relationship exists between man's thoughts and reality is itself a claim purporting a truthful relationship about that which the claim asserts as impossible. One cannot know and not know about the existence of things and their natures at the same time.

Given that we can know of things and their natures, it also follows that we can identify similarities and differences between things and their natures. In other words, we can make distinctions. The senses are our connection with reality. Our senses produce sensations when they come into contact with things in the world of reality. These sensations are perceived by the mind. As we will discuss these perceptions are of a nature that we can isolate certain characteristics of things and compare them.

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[41] As cited in St. Thomas Aquinas, "On Natural Science, Mathematics and Metaphysics," *Selected Philosophical Writings*, trans. Timothy McDermott (Oxford: Oxford University press, 1993) p. 1-2.

The act, which was discussed earlier, of apprehension, will be reviewed and a relationship between direct ideas, reflexive ideas, and reflection to reality will be discussed. "Apprehension is an act of the mind which merely represents an object and does not involve in itself a mental assertion."[42] When the apprehension is viewed as representing an object and not as an act Toohey calls this an idea, concept or notion.[43] Apprehension is a cognitive act; ideas, notions or concepts are apprehensions viewed as representing objects. Toohey also attributes the following. "A direct idea is an idea which represents something outside the mind; e.g. the idea of a tree. A reflex idea is an idea which represents something inside the mind; e.g. the idea of an abstraction. Reflection is an act of the mind by which it turns to contemplate its own acts."[44] Two types of reflection include psychological reflection and ontological reflection. "Psychological reflection is an act of the mind by which it turns to contemplate its own acts so far as they are acts or modifications of the soul. Ontological reflection is an act of the mind by which it turns to contemplate its own acts as they are representations, that is, so far as they represent an object."[45] Toohey relates the two types of reflection, as when the mind contemplates its apprehension as an act of the mind while disregarding that the apprehension is the representation of an object as psychological reflection. Distinguishing ontological reflection as being when the mind contemplates its apprehension as the representation of an object, while ignoring it as an act of the mind. When discussing the

[42] John J. Toohey, S.J. *Notes on epistemology* (Origin of manuscript unknown). P. 1.Toohey also notes, "For example, the act of the mind which represents 'house', or 'water', or 'America' is an apprehension." (From same).
[43] Ibid.,P. 1.
[44] Ibid., P. 1.
[45] Ibid., P. 1.

two forms of reflection, we must distinguish between the material and formal objects of the two.

Kant's distinctions are a description of how things are grasped, becoming logical truths. This is a half of the story; the first point raised in the quote from Boethius refers to how things are understood. To understand something we must discuss it in accordance with **its** nature. If we are discussing a goat, the description of the goat must coincide with its true nature in order for it to be understood. If we attach a causal relationship the goat as a cause of some effect, then if the effect exists, the goat, as the cause, must also exist in order for the statement regarding the relationship between the goat and its effect to be understood.

Utility, ideas, and the nature of truth are unobservable and untestable. These things are not extended in time or space and cannot be measured, or observed externally through the senses. We know them through psychological reflections of our mind's actions. The scientific method is a clear-cut example of this. We can use the scientific method to test certain propositions, the reaction between two chemical substances for example. A problem arises when one says that this method is the only method for discovering truths about reality. How can we test the scientific method for truthfulness, in other words, how do we know that this method is capable of producing logical truths? The answer is we cannot. We cannot come up with a variable that describes truthfulness and test it against anything. Instead the source of the scientific method must be something other than itself.

The scientific method is the result of our pre-established knowledge about what is and isn't true, and cause and effect. This is apparent. If true, and thus untrue, were not already established categories in our minds, then how could we ever learn from experience? What would be the source of truth? We might see things or hear them, but we could not even make a connection between these events and their existence.

This brings us to the necessary relationship between analytic statements in a theory and observable phenomena. If a theory is true, then the theory must fulfill a certain criteria. The things in the theory must exist if the phenomenon exists. It would, of course, be possible to derive a true theory about things, which didn't exist as stated, had imaginary natures and caused imaginary phenomena through imaginary relationships that follow from the imaginary things. This type of theory, while true, would be useless in describing phenomena that exist outside of this imaginary world. This theory would not be ontologically correct in describing mind-independent phenomena. In fact, it could not even be conceived if the elements in the theory describing certain objects could not possibly coalesce into a unity. We could not, for example, come up with theories about balls that are both red and non-red all over at the same time in the same respect. To attempt to do so would be in error, since the mind must accept the object and understand it. The mind cannot understand impossibility, or to use Toohey's term an unreality. It might be a source for some mind game or logic puzzle, but it could not be a logical truth in relation to any ontological truth.

If a bobble has a certain nature and a google has another nature, when these two things are put together under certain conditions a booggle is created may be true. But this imaginary theory is useless in describing the formation of salt (from sodium and

chlorine). A bobble, a google and a boogle do not exist as things in a mind-independent reality, such as salt, sodium and chlorine. They are only mind-dependent things (thoughts). Using the google, bobble theory to explain the formation salt would not be science, but rather a joke.

Theory must account for the true nature of a thing to be useful. If Zeus does not exist as an entity in the mind-independent reality, only as an idea, but is defined as an omnipotent god capable of throwing lightening down from the heavens when angered. We cannot attribute the lightning we see as being from an angry Zeus. If some human goal could be accomplished by ending the lightening, our knowledge of Zeus would not be useful or true in ending the lightening storm.

The method used to examine things must proceed from both the nature of the thing and our nature. As we have said earlier, understanding and grasping are two necessary prerequisites to science. In order to carry on a discussion about a thing, its nature, or a relationship between a thing and others we must take into account both the nature of the thing and our own nature**.** The nature of the thing under consideration has a great deal to do with how we obtain knowledge about it. Through the senses we can obtain knowledge about some material objects and relationships between material objects. When one wants to investigate the nature of human actions, or their logical structures, the physical senses are incapable of giving knowledge about mind-dependent things such as utility and goals. Only through psychological reflection can one know about these concepts.

This goes against what is typically called scientific. In physics for example the existence of problematic objects are used to explain the existence or characteristics of realities. These types of theories, while useful possibly and possibly accepted, are not known! Instead, the theory itself is a problematic object and not a reality. In the case of such theories, the coalescence of the problematic objects and their explanation are not known to coalesce. Rather it is judgment and not knowledge that would lead one to accept such theories, even though they may well turn out to be true! The existence of some particle or another as determined by the works of physicists may turn up to be problematic. The use of the existence of such particles to explain the characteristics or existence of other objects is problematic, not based on necessary truths, or knowledge.[46]

A key aspect of the nature of a concept is whether or not it is a first principle. If starting from a first principle then, according to Aristotle, deduction is the proper method to come to conclusions. If we are working towards a first principle then introspection or induction is the proper method. Once a first principle is speculated on it must be a necessary statement. As such, it can be known in that it is the only possible case. To discover this, the denial of the proposition must involve use of the proposition being denied. To deny *p*, it must be necessary to use *p* in its own denial. Another proof is that of the use of a performative contradiction, an example one must consciously act to deny that human beings must consciously act.

[46] This is not a criticism since necessary foundations may not be known at all. However, we can not say with certainty that a problematic object causes or acts on a reality. Expediency and scarcity of the means to develop purely scientific theories deduced from axioms leads to the acceptance and use of such theories. The truths contained in them are merely incidental. While all of this is true, such theories may be the best possible explanation but there are better alternatives top them such as a true science deduced from axioms.

Aristotle, in book VI of the *Nicomachean Ethics*, talks about the difference between induction and deduction in their relationship to first principles.

> "Induction introduces us to first principles and universals, while deduction starts from universals. Therefore there are principles from which deduction starts which are not deducible; therefore they are reached by induction. Thus scientific knowledge is demonstrative state, . . . i.e. a person has scientific knowledge when his belief is conditioned in a certain way, and the first principles are known to him; because if they are not known to him then the conclusions drawn from them he will have knowledge only incidentally.[47]

Quoting David Gordon in discussing Aristotle's views regarding induction and deduction, we find the method described in complete accordance with Aristotle.

> Where does this notion of science originate? Although, as earlier mentioned, it is very difficult in intellectual history to demonstrate direct influence, I think it is no accident that the idea of a deductive science is found in Aristotle's *Posterior Analytics*. Aristotle argues that a complete science must start with a self-evident axiom and, by the use of deduction, exfoliate the entire discipline. Often conditions force the use of more empirical hypotheses, but this is a mere expedient.[48]

In the natural sciences an inductive search from things to their first causes is the only method capable of resulting in first principles. We must first move from observable events back to things and their natures and the relationships between prior things. First principles can first be discovered by induction, however, introspection, called the reflexive act by Toohey, is the way to discover whether it is a first principle. By reflecting upon things, which are already a part of our nature, we can come up with first principles through reflecting on our actions. We might note that I always use scarce means to accomplish a goal through the psychological reflective act. Then one might

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[47] Aristotle, *The Ethics of Aristotle: The Nichomachean Ethics*, trans. J. A. K. Thomson, rev. by Hugh Tredennick (Harmondsworth, Middlesex, England: Penguin Books Ltd., 1984). P. 207.

[48] David Gordon, *The Philosophical Origins of Austrian Economics* (Auburn, Al.: Ludwig von Mises Institute, 1993) p. 27. Gordon also adds in a footnote (10) "Aristotle believed that through induction, one can arrive at true first principles. These form the basis of science."

consider 'could I consciously not act' in doing so he would realize that this is an impossibility. The elements of the absence of conscious action and a human being cannot coalesce into unity.

Science and knowledge

In order for science to differentiate itself from witchcraft, alchemy, or fraud, it must be the discovery of things, their natures and the relationships between things.[49] To do so, it must examine the phenomena under its jurisdiction in a manner that reflects the subject matter and our minds in order for it to be both grasped and understood. In accomplishing the aforementioned task, it must add to the stock of present knowledge. In doing so, theory must be deduced from true necessary statements. Anything less is an expediency measure and not an addition to our knowledge. Any correlation between a theory not produced in this manner and knowledge is incidental.

The Distinctions Between, Acceptance, Usefulness, and Truthfulness.

> *All I have to say is this: being true is different from being taken to be true, whether by one or many or everybody, and in no case is to be reduced to it. There is no contradiction in something's being true which everybody takes to be false.*[50]

Is there a distinction between the three concepts of acceptance, usefulness and truthfulness in terms of scientific theories? Do the three things correspond to each other in any meaningful way? An examination of the relationship between these concepts is crucial to any examination of the history of science.

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[49] While others may consider such activities 'science' it is no way consistent with our definition of complete science as the discovery of things, their natures, and the relationships between things. This task can only be accomplished through observing and classifying things, and then deducing theory from necessary synthetic statements. Only in this way can we describe that activity as scientific and an addition to the stock of knowledge.

[50] From Frege, *The basic Laws of Arithmetic: An Exposition of the System*, ed. and trans. M. Furth (Berkeley, Ca.: University of California Press, 1969). P. 13. As cited in David R. Cerbone, "How To Do

The history of science is a look through time at the people, places and ideas of the past. What ideas were used in the past, where and from who did they come, and when were they introduced. Another aspect of the history of science is judging the progress of science. Is 1870's economic theory a progression over the economic theory of 1650? Is Adam Smith's *The Wealth of Nations* an improvement over the works of Cantillion? These are typical of the types of questions answered in any work on the history of science. Under what criteria should a theory be judged? Before we can answer these questions, we must first understand the relationship between truthfulness, acceptance and usefulness.

Scientific theory fulfills the categories of being a thing and can also be truthful, accepted and useful, making it a good. To discuss the relationship between scientific theory, and usefulness, acceptance and truthfulness we can look to economics, in this case Carl Menger.

> Things that can be placed in causal connection with the satisfaction of human needs we term *useful things*. If, however, we both recognize this causal connection, and have the power to actually direct the useful things to the satisfaction of our needs, we call them *goods*.
>
> If a thing is to become a good, or in other words, if it to acquire good-character, all four prerequisites must be simultaneously present:
>
> 1. A human need
> 2. Such properties as render the thing capable of being brought into a causal connection with the satisfaction of this need.
> 3. Human knowledge of this causal connection.
> 4. Command of the thing sufficient to direct it to the satisfaction of the need.
>
> Only when all four of these prerequisites are present simultaneously can a thing become a good. When even one of them is absent, a thing already possessing goods-character would lose it at once if but one of the four prerequisites ceased to be present.[*]
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> Hence a thing losses its goods-character: (1) if, owing to a change in human needs, the particular needs disappear that the thing is capable of

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Things with Wood: Wittgenstein, Frege, and the Problem of Illogical Thought", *The New Wittgenstien*, Ed. A Crary and R. Read (London: Routledge, 2000).

satisfying, (2) whenever the capacity of the thing to be placed in causal connection with the satisfaction of human needs is lost as a result of a change in its own properties, (3) if knowledge of the causal connection between the thing and the satisfaction of human needs disappears, or (4) if men lose command of it so completely that they can no longer apply it directly to the satisfaction of their needs and have no means of reëstablishing their powers to do so.

A special situation can be observed whenever things that are incapable of being placed in any kind of causal connection with the satisfaction of human needs are nevertheless treated by men as goods. This occurs (1) when attributes, and therefore capacities, are erroneously ascribed to things that do not really possess them, or (2) when non-existent human needs are mistakenly assumed to exist. In both cases we have to deal with things that do not, in reality, stand in the relationship already described as determining the goods-character of things, but do so only in the opinions of people. Among things of the first class are most cosmetics, all charms, the majority of medicines administered to the sick by peoples of early civilizations and by primitives even today, divining rods, love potions, etc. For all these things are in capable of actually satisfying the needs they are supposed to serve. Among things of the second class are medicines for diseases that do not actually exist, implements, statues, buildings, etc., used by pagan people for the worship of idols, instruments of torture and the like. Such things, therefore, as derive their goods-character merely from properties they are imagined to possess or from needs merely imagined by men may appropriately be called *imaginary* goods.**

As a people attains higher levels of civilization, and as men penetrate more deeply into the true constitution of things and of their own nature, the number of true goods becomes constantly larger, and as can easily be understood, the number of imaginary goods becomes progressively smaller. It is not unimportant evidence of the connection between accurate knowledge and human welfare that the number of so-called imaginary goods is shown by experience to be usually greatest among peoples who are poorest in true goods.

Footnotes from the original

* From this it is evident that goods-character is nothing inherent in goods and not a property of goods, but merely a relationship between certain things and men, the things obviously ceasing to be goods with the disappearance of this relationship.

> ** Aristotle (*De Anima iii.10. 433^{a} 25-38)* already distinguished between true and imaginary goods according to whether the needs arise from rational deliberation or are irrational.[51]

Although Menger is discussing the relationship between things and their goods-character, we must also remember that universals are also things. While the relationship between physical things and mind-dependent things (ends, and utility) are established in goods theory, the idea concerning the causal connection is also a thing. A known universal must consist of three truths. One, an ontological truth, the universal must exist in reality. Two, a logical truth, is the identity of what is assented to with reality. And finally, if it is to be discussed, a moral truth, in terms of what is both a logical and an ontological truth, requires that what a man says must be identical to what he assents to.

The nature of a thing acquiring goods characteristics presupposes the existence of ideas. An idea is a motivating factor in the creation of a good. Without the causal connection between some thing and a human need, no goods exist. This idea is also a good. In the case where the causal relation is true, it is a true good. In the case where the relationship is false it is an imaginary good. We can also say that when the relationship between a thing and a goal is incorrect that the individual concerned has made a mistake or an error. [52]

In the previously stated example of boggles and googles that relationship is imaginary and would constitute an imaginary good in the case someone were to accept it in attempting to use the relationship to produce salt. Relationships are either true or untrue. The acceptance or rejection of those relationships has no correlation with their

[51] Carl Menger, *Principles of Economics*, trans., James Dingwall and Bert Hoselitz (Grove City, Pa.: Libertarian press, Inc, 1994). P. 52-54. (Italics in the original) (Footnotes from the original).

truthfulness *prima fascia.* To accept an idea is not to make it true. False ideas may be accepted. Errors can be made.

Ideas and theories must be learned after their initial discovery. This makes them scarce; if they were not the title professor would not be an occupational one. Ideas concerning various relationships are scarce and under the criteria described above become goods. Using Menger's terminology, " Things that can be placed in causal connection with the satisfaction of human needs we term *useful things*."[53] Thus a theory, which tells us the truthful relationship, is a useful thing. This does not, however, make that thing a good. For example, a true proposition about the relationship between things that are not capable of a connection between things and some human needs would not be a good. Some human need is a prerequisite for a good. Thus everything that is truthful is not necessarily useful, nor accepted; everything that is useful is true in terms of ideas. Acceptance is based not necessarily on usefulness, but rather perceived usefulness prior to its use.

Menger adds, “If, however, we both recognize this causal connection, and have the power to actually direct the useful things to the satisfaction of our needs, we call them *goods*."[54] Ideas, which possess the truthful relationship between things, must be known before they can start to possess goods-character. In addition they must be capable of being understood and grasped in order that we may direct them towards the satisfaction

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52 The error of incorrectly associating an imaginary good with the satisfaction of a goal is just one type of mistake or error. It could also be that one anticipated some accomplished goal would supercede another possible goal in importance (*ex-ante)*, yet realize later this was not the case (*ex-post*).

[53] Carl Menger, *Principles of Economics*, trans., James Dingwall and Bert Hoselitz (Grove City, Pa.: Libertarian press, Inc, 1994). P. 52

[54] Carl Menger, *Principles of Economics*, trans., James Dingwall and Bert Hoselitz (Grove City, Pa.: Libertarian press, Inc, 1994). P. 52

of some need. In order to gain this understanding we must learn them and accept them as possessing the characteristics of a good.

The concept of truthfulness, as discussed earlier, relies on existence. Does a thing exist as stated? This concept is a part of the nature of a true good. (1) Does a human need exist? (2) Does the relationship between the thing and a human need exist? (3) Is this connection between the thing and the need known? (4) Can this thing be directed towards the satisfaction of this need? Truthfulness is not all that is needed for an idea to be a good, only a part of the character needed for goods character. In the case of imaginary goods truthfulness is absent some way or another. The need does not exist, or the relationship between the thing and the need does not exist. In this case an error has been made. Imaginary goods, in terms of false causal relationships, have their corollary in epistemology; we call it a logical falsity.

From the above we can see that acceptance and truthfulness are not synonymous. Something can be accepted which is not true. Things are accepted based on their perceived usefulness. It is possible to accept something which is perceived as being useful, but which turns out not to be useful, thus untruthful. Theories, which conform to this, are imaginary goods, using Menger's terminology. Causal relationships, which are assented to, but not ontological truths, are called logical falsities.

The Relationship Between Epistemology and Science Revisited

The key elements in the relationship between epistemology and science are of the utmost important. We can through the principles of epistemology evaluate science, methods and subject. We can through the foundations of epistemology evaluate the tasks of science. We can evaluate scientific works to see if they are identically performed to accomplish these tasks.

The tasks of science involve the discovery of ontological truths, thus creating logical truths. "Logical truth is the identity of what is assented to with reality."[55] The assenting to the existence of things, their natures, and universal relationships among them is but one aspect of the history of science. A key aspect of this is discovering distinctions between things. What types of things are different than others, the classification of genus and species? The next step involves the communication of these ideas, scientific discourse. An idea once known is spread. This is the truly visible aspect of science, or the easiest to observe. We cannot always look at a scientist performing the task of discovering ontological truths and correctly interpret what he is doing. To look at an economist sitting at his desk, contemplating the relationship between some oil crisis and the effects it will have on the price of retail stock prices is not a satisfactory observation on what he is doing. Instead we "observe" science when it is being discussed. If Einstein had merely discovered his relativity theory, assuming it is true, no one would have known about it until he tried to gain acceptance for his theories through lecturing and writing. History of science writers must be concerned with the validity, originality and place of various truths and fallacies, their effects on a particular science and outside factors, which

[55] John J. Toohey, S.J. *Notes on epistemology* (Origin of manuscript unknown). P. 4.

led either to their acceptance or rejection. They must begin with a solid foundation, an epistemological one, if they are to be given any hope of accomplishing this task.

Summary of the Problem Solved?

Skepticism while a valid tool for inquiry should not be viewed as a premise. To do so involves one in a performative contradiction. If one were skeptical about man's ability to understand or know things about the real world, then one would be using its contrary; that we can understand or know things in the real world. In addition, I believe that an indirect proof exists giving us knowledge of our ability to understand and know things about the real world. To say that man cannot understand or know things about the real world is to make a claim of knowledge about the relationship between man's knowledge, or ability to obtain it, and the real world. A link between the mind and reality has already been established as a prior claim to its negation. This clearly does not establish that we are capable of knowing everything, or understanding everything about the external reality, merely that it is possible and that we do indeed posses such knowledge (the fact that we can understand or know things about the real world.)

This fact must be the starting point for any epistemology and thus must be a premise in any methodology, as any methodology must be based on an epistemology. It is impossible for any methodology to exist, and not contradict itself, in the absence of this premise. In the premise that we can know things about the real world is inherent the ability to distinguish between truth and falsehood. This is not a claim that one cannot be mistaken; only that one can know. For something to be true it must exist, or be. As Aristotle defines being as ". . . whatever makes a proposition true." For something to be true it must exist.

In order to know something it must be true, thus the existence of ontological truth must precede the formation of logical truths. Once one has assented to the existence of an ontological truth, it then becomes a logical truth. The existence of a thing, an ontological truth must in all cases precede our knowledge of them. The ontological truth must in all cases precede the logical truth. In the same manner a logical truth, the assenting to that which exists and how it exists, must also precede a moral truth, which corresponds to an ontological truth. One cannot communicate what one assents to prior to assenting.

The preceding ideas lead one to a discussion of how information regarding truths is formed. From Fr. John Toohey's description of Thomistic thought, the mind apprehends objects through sense experience or through reflection. Things external to the mind may be apprehended either through the senses, *synthetic a posteriori* propositions, or through ontological reflection as *synthetic a priori* propositions about mind-independent phenomena. Or, they can be examined through psychological reflection to from synthetic a priori truths regarding mind-dependent phenomena. By examining the elements proposed about various objects and their ability, or inability, to coalesce into a reality, we can come to know of things, their natures and the relationships between things. Once we have formed these first principles we can deduce theory from them. Anything else, in terms of a theory, is something less that complete science. Here I have attempted to integrate Kantian knowledge categories into the Thomistic framework to both explain and understand the possibility of a complete science and to describe the process of explanation. Boethius describes the process of logical truth formation. To discuss a thing, the thing must be discussed in a way in which it may be both grasped and understood. The thing must be discussed in a way that suits both the thing being

discussed and ourselves. In order to discuss anything it must be discussed in a way in which others can understand this way of discussion must be in accordance with our logical structures. The way in which we discover new ideas is where Kant fits into the Thomistic framework. Kant's knowledge distinctions are distinctions that describe the way in which ideas are grasped. We can understand things through observation, the synthetic a posteriori, and through reflection, the synthetic a priori. The Kantian distinctions fit into the Thomistic framework by describing the process of the formation of logical truths.

The intent of this section dissertation deals with the history of science. In order to relate what was discussed earlier a definition of science had to first be put forth. The only meaningful definition science that is both general and fits a form that we can grasp is; science is the discovery of things, their natures and the relationships between things. In this manner we can describe science in a way that leads to the accumulation of knowledge. The success of any scientific endeavor rests on the relationship between the premises and their existence. The nature of a pure science is one that rests on universal, necessary truths as their premises. Any other deductive system is false or only true incidentally, and does not produce knowledge concerning information about things, their natures and relationships between things. Inductive activities are not purely scientific and are merely expedient and only useful in moving from particulars to eliminate potential premises.

The possibility of an empirical science must be raised here. While it is possible to eliminate potential premises through empirical activity, it is never possible to induct universals from empirical observation. The reason for this rests on the definition of a

universal. To be a universal truth, a statement must be self-evident. While we can observe particular things through sense experiences, we can never prove their negation to be impossible through empirical observation. Because I have not seen a black swan does not negate the existence of a black swan.

An additional aspect is explained in that necessary truths are possible and can only be of a *synthetic a priori* nature. A necessary truth can only describe the nature of some logical truth. They must be of a *synthetic a priori* nature since only the mind can ponder the denial of any proposition.

To discuss science, is to discuss an action. An action directed towards a goal. As such scientific actions fall under the same general category of action that other economic activities do. Lord Robbins describes economics as the science that attempts to describe human behavior as a relationship between ends and scarce means that have alternative uses. Scientific activity falls under this category. As such any history of science must be described and understood through an economics framework.

In describing scientific activity through an economic framework, the existence of error, and goals, as fundamental consequences of human action, must be included. While a pure view of science incorporates a search for truth, human activity sometimes has different purposeful ends. The discussion of truthfulness, acceptance and usefulness comes into any credible discussion on scientific activity.

All human action is directed towards the future accomplishment of some given goal. The variety amongst human beings leads to a variety of goals towards which scientific activity is directed. This would be fine and of no consequence provided the set of accepted ideas, truthful ideas and useful ideas where identical. This is unfortunately

not the case, for the essential reasons that errors are possible and goals vary. The truth doesn't feed people; useful things and useful actions do, either directly or indirectly.

The acceptance of ideas is based on their usefulness, since acceptance is an action and as such must be directed towards the satisfaction of some given, but varied amongst individuals, goal. These goals can be the search for truth to answer a question, to find the truth as an end itself, or as a means to the accomplishment of some material or spiritual end. These goals can be legitimate in the sense that they are related to the successful accomplishment of their stated goal, or directed not to the accomplishment of their stated goals, but rather to the accomplishment of some unstated goal, which may or may not depend on deception.

In the next section, a theory will be presented that is in accordance with the epistemological views expressed in this chapter, and the economic nature of scientific activity. Any examination must include the discussions previously mentioned. In order to discuss science and evaluate previous thinkers one must have a standard against which to judge and place their contributions in some relation to others. The next section will be an attempt to derive a standard to accomplish these goals compatible with the ideas expressed in the previous section.

CHAPTER III: KUHN, HISTORY OF SCIENCE AND ECONOMICS: AN EXAMINATION OF THE HISTORY OF SCIENCE LITERATURE

The first chapter of Thomas S. Kuhn's book *The Structure of Scientific Revolution* begins by attacking the theory of history that will be called the Whig theory of history. The Whig theory of science is the story that science is one of incremental progress towards the truth. That what is contained in current science is the distillation of the best from the past and current improvements. If this is so, current text and journal articles contain the best science has to offer and what comes earlier is inferior, or at least no better than what is contained by the dominant current paradigm. There is no loss of knowledge; the theories and paradigms of the past are inferior to those of the present. The course of science is towards an ever-improving route to the truth.

> If science is the constellation of facts, theories, and methods collected in current texts, then scientists are the men who successfully or not, have striven to contribute one or another element to that particular constellation. Scientific development becomes the piecemeal process by which these items have been added, singly and in combination, to the ever-growing stockpile that constitutes scientific technique and knowledge. And history of science becomes the discipline that chronicles both these successive increments and the obstacles that have inhibited their accumulation. Concerned with scientific development, the historian then appears to have two main tasks. On the one hand, he must determine by what man and at what point in time each contemporary scientific fact, law, and theory was discovered or invented. On the other hand, he must describe and explain the congeries of myth, error, and superstition that have inhibited the more rapid accumulation of the constituents of the modern science text.[1]

[1] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 1-2.

Kuhn points out that these texts (classics and textbooks) have often seemed to imply that "the context of science is uniquely exemplified by the observations, laws, and theories described in their pages."[2] The 'textbook' history of a science is defined by the dominant paradigm. Works important enough to become classics are deemed so in their relation to the dominant paradigm. The textbooks evaluate previous works and their relevance to inclusion based on their relationship to the dominant paradigm's observations, laws and theories. These textbooks and classics are the subject material through which the historian of science goes about his task.

Kuhn then lays out problems with this Whig history of science, with science as an ever-progressive march towards enlightenment.

> In recent years, however, a few historians of science have been finding it more and more difficult to fulfil the functions that the concept of development-by-accumulation assigns to them. As chroniclers of an incremental process, they discover that additional research makes it harder, not easier, to answer questions like: When was oxygen discovered? Who first conceived of energy conservation? Increasingly, a few of them suspect that these are simply the wrong sorts of questions to ask. Perhaps science does not develop by accumulation of individual discoveries and inventions. Simultaneously, these same historians confront growing difficulties in distinguishing the "scientific" component of past observation and belief from what their predecessors had readily labeled "error" and "superstition." The more they study, say, Aristotelian dynamics, philogistic chemistry, or caloric thermodynamics, the more certain they feel that those once current views of nature were, as a whole, neither less scientific not more the product of human idiosyncrasy than those current today.[3]

The tasks of historians of science, within the Whig tradition, to attribute the discovery of things to various scientists and times are difficult. Kuhn attributes this difficulty to the changing of terms and interpretations of relationships throughout various revolutions in science. There is a problem also in constituting what is science, or scientific. Kuhn maintains that throughout the historical periods that he has come into contact with, and those of the historians he mentions, that they appear as scientific in the

[2] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press,

past as the present. In other words, he sees no significant differences in the scientific nature of the works of past paradigms from the current scientific research. Differences in theoretical assumptions follow from the context of discovery. At different times and different places, due to personal or historical accidents, different paradigms are formed based on different metaphysical and methodological beliefs. In addition, the acceptance of theory, after observations and experiments are performed, are not based on the results of these outcomes, but along non-logical processes. As we will come to see, Kuhn believes that the acceptance of paradigms is based on faith. Faith that a particular paradigm will be better than its competitors is providing solutions to problems. The subjective nature of paradigm acceptance and the 'fact' that different paradigms within a field are incommensurable in terms of each other leads Kuhn towards a nihilist conclusion regarding progress in science. If this is true, then paradigm shifts are not the result of an enhanced scientific nature to a new paradigm over a past, but rather to non-scientific concerns (in the context of discovery and acceptance). Kuhn does not recognize the distinctions between the "context of discovery" and the "context of justification" and in fact seems to have problems with the "context of justification" as a whole.

The context of justification deals with the testing and validation of theories. The context of discovery deals with the generation of scientific hypothesis and theories. While there is debate as to the validity of the distinctions, context of discovery and context of justification, Kuhn himself discusses them, and we will here.[4] If all of these instances that Kuhn, and others, examined were equally scientific, then the differences between them must have come as a result of what Kuhn calls "their incommensurable

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1962), p. 1-2.
[3] Ibid., p. 2.

ways of seeing the world and practicing science in it."[5] He goes on to add, "Observation and experience can and must drastically restrict the range of admissible scientific belief, else there would be no science. But they cannot alone determine a particular body of such belief. An apparent arbitrary element, compounded of personal and historical accident, is always a formative ingredient of the beliefs espoused by a given scientific community at a given time."[6]

According to Kuhn, the different natures of these disciplines are the results of different views regarding how the world works. The beliefs are at least partially determined by arbitrary experiences of personal and historical accident. This indicates that Kuhn thinks science is bounced around due to chance, in essence, and not ever increasing awareness about reality. Paradigm shifts are not necessarily advances in terms of the new versus the old. The worthiness of new theories or paradigms cannot be compared to that of older theories or paradigms due to their incommensurability.

Scientific research cannot begin until questions such as, "What are the fundamental entities of which the universe is composed? How do these interact with each other and with the senses? What questions may be legitimately asked about such entities and what techniques employed in seeking solutions?"[7] In the "mature science, answers to these questions are firmly embedded in the educational initiation that prepares and licenses the student for professional practice."[8] In mature sciences, these questions are answered by the formation of a paradigm. When enough of the scientific community in a field agrees to answers to these questions, they form a paradigm. During periods of what

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[4]Ibid., p. 8-9.
[5] Ibid., p. 4.
[6] Ibid.
[7] Ibid., p. 4-5.

Kuhn calls normal science, practitioners within a field, work within the limits set out for it by a paradigm that addresses these questions.

The traditional view is that the theory of justification is determined by logic. Philosophy has a one-way street in giving the empirical sciences the types of tests they must use to justify theories. The context of discovery is the province of historians, psychologists and sociologists. These are, in accordance with the traditional view, empirical sciences themselves. To discover why particular groups or persons developed a certain hypothesis and theory is not the field of the philosopher, and not determined by logic. It is rather, as Kuhn claims due in part to "an apparent arbitrary element compounded of personal and historical accident."[9]

In practicing normal science, research is defined by Kuhn as a "strenuous and devoted attempt to force nature into the conceptual boxes supplied by professional education." During periods of 'intellectual peace' for a dominant paradigm, the bulk of the work done by scientists within a field is normal science. Work is done within the confines of the expected results of experimentation, and the metaphysical, methodological beliefs espoused by the paradigm. The paradigm defines among other things the acceptable things for the scientist to study, expectations, through theory, for what one should discover, and the methods to be used. "Normal science, the activity in which most scientists inevitably spend almost all their time, is predicated on the assumption that the scientific community knows what the world is like. Much of the

[8] Ibid., p. 5.
[9] Ibid., p. 4.

success of the enterprise derives from the community's willingness to defend that assumption, if necessary at considerable cost."[10]

There are always problems within a paradigm, results from research that defy explanation and things the paradigm should be able to solve but cannot. During periods of normal science,

> Normal science, for example, often suppresses fundamental novelties because they are necessarily subversive of its basic commitments. Nevertheless, so long as those commitments remain an element of the arbitrary, the very nature of normal science research ensures that novelty shall not be suppressed very long. Sometimes a normal problem, one that ought to be solvable by known rules and procedures, resists the reiterated onslaught of the ablest members of the group within whose competence it falls. On other occasions a piece of equipment designed and constructed for the purpose of normal research fails to perform in the anticipated manner, revealing an anomaly that cannot, despite repeated effort, be aligned with professional expectation. In these and other ways, besides, normal science repeatedly goes astray. And when it does –when, that is the profession can no longer evade anomalies that subvert the existing tradition of scientific practice –then begin the extraordinary investigations that lead the profession at last to a new set of commitments, a new basis for the practice of science.[11]

Here the road to scientific revolution is laid out. Paradigm shifts occur when the anomalies that are not explained within the paradigm add up, so to speak. During normal times, these anomalies are suppressed. They are either put back out of discussions, or explanations are given as to why the phenomena cannot, yet be explained under the current orthodoxy, but confidence is assured that the phenomena can somehow be explainable under the current paradigm in the future. The development of new instruments or other developments will arise and the phenomena will be explained. Kuhn points out that revolutionary change is not the result of conversions by members of the old paradigm. It is the new entrants into a field who are the revolutionaries, that it is they who alter the field by accepting alternative paradigms. Members of a paradigm do not

[10] Ibid., p. 4.
[11] Ibid., p. 5-6.

change their stripes, so to speak, but new entrants betray their masters in accepting a paradigm in a revolutionary form.

This phenomena, and regularity, that Kuhn uncovers will play a large role in the further discussions in reconstructing Kuhn. Why is it that . . .?

1) New entrants to a field undertake scientific revolution.
2) Members of the old paradigm do not jump ship.
3) The existences of anomalies exist throughout the life of a paradigm, why can they suppress such anomalies for a period of time and why do these anomalies suddenly produce a crisis situation at particular times and not others? Is it just the adding up of anomalies to a certain threshold that triggers revolution within a field, or are there other factors that lead to revolution?
4) Could factors outside of the scientific community trigger revolution?

Upon arrival at this crisis situation, whatever may trigger it, this begins, and ". . . the extraordinary investigations that lead the profession at last to a new set of commitments, a new basis for the practice of science. The extraordinary episodes in which that shift of professional commitments occurs are the ones known in this essay as scientific revolutions. They are the tradition-shattering compliments to the tradition-bound activity of normal science."[12]

After establishing his theory, Kuhn then goes on to apply them to the revolutions associated with men like Copernicus, Newton, Lavoisier, and Einstein, all examples drawn from the empirical physical sciences. According to Kuhn, these changes in paradigms of the physical sciences "Most clearly than most other episodes in the history

[12] Ibid., p. 6.

of at least the physical sciences, display what scientific revolutions are about."[13] The shift in each episode "necessitated the community's rejection of one time-honored scientific theory in favor of another incompatible with it."[14] As a result

> Each produced a consequent shift in the problems available for scientific scrutiny and in the standards by which the profession determined what should count as an admissible problem or as a legitimate problem-solution. And each transformed the scientific imagination in ways that we shall ultimately need to describe as a transformation of the world within which scientific work was done. Such changes, together with the controversies that almost always accompany them, are the defining characteristics of scientific revolution.[15]

The problem confronted by practitioners of the 'old' paradigm, when confronted by new theories, during the transition period is how to reconstruct or adjust their previous beliefs to accommodate the new theory. In addition, other things can cause revolution such as the discovery of new things, or of something previously not thought to exist.

> The invention of other new theories regularly, and appropriately evokes the same response from some of the specialists on whose are of special competence they impinge. For these men the new theory implies a change in the rules governing the prior practice of normal science. Inevitably, therefore, it reflects upon much scientific work they have already successfully completed. That is why a new theory, however special its range of application, is seldom or never just an increment to what is already known. Its assimilation requires the reconstruction of prior theory and the re-evaluation of prior fact, an intrinsically revolutionary process that is seldom completed by a single man and never overnight.[16]

One area of importance to the rest of this dissertation will be statements made by Kuhn regarding the "context of discovery" and the "context of justification" and the Ability of history to "effect the sort of conceptual transformation aimed at here."[17] Kuhn concludes his first chapter with the following few paragraphs.

> Undoubtedly, some readers will already have wondered whether historical study can possibly effect the sort of conceptual transformation aimed at here. An entire arsenal of

[13] Ibid.
[14] Ibid.
[15] Ibid.
[16] Ibid, p. 6-7.
[17] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 8.

> dichotomies is available to suggest that it cannot properly do so. History, we too often say, is a purely descriptive discipline. The theses suggested above are, however, interpretive and sometimes normative. Again, many of my generalizations are about the sociology or normal psychology of scientists; yet at least a few of my conclusions belong traditionally to logic or epistemology. In the preceding paragraph I may even seem to have violated the very influential contemporary distinction between "the context of discovery" and "the context of justification." Can anything more than a profound confusion be indicated by this admixture of diverse fields and concerns?
>
> Having been weaned intellectually on these distinctions and others like them, I could scarcely be more aware of their import and force. For many years I took them to be about the nature of knowledge, and I suppose that, appropriately recast, they have something important to tell us. Yet my attempts to apply them, even *grosso modo*, to the actual situations in which knowledge is gained, accepted, and assimilated have made them seem extraordinarily problematic. Rather than being elementary logical or methodological distinctions, which would thus be prior to the analysis of scientific knowledge, they now seem integral parts of a traditional set of substantive answers to the very questions upon which they have been deployed. That circularity does not at all invalidate them. But it does make them parts of a theory and, by doing so, subjects them to the same scrutiny regularly applied to theories in other fields. If they are to have more than pure abstraction as their content, then that content must be discovered by observing them in application to the data they are meant to elucidate. How could history of science fail to be a source of phenomena to which theories about knowledge may be legitimately be asked to apply?[18]

Here Kuhn points to some issues that will be addressed at the end of the chapter and alternative solutions proposed in chapter 4. Is history or the historical method the proper method about which to determine answers to the development of sciences? In order to view history, theory is a necessary precondition. To examine historical events such as the development of a paradigm, and its acceptance as the dominant paradigm, some theory must already exist to relate the two. To observe, say the publishing of a book, which later turns out to be a classic, and its acceptance by practitioners of a scientific field, is to state the relationship that ideas communicated to others must precede the acceptance of those ideas. In addition, one must relate the acceptance of a paradigm to scientific progress, or regression. To do these things, a theory must be pre-established in order to determine which events are related to others.

[18] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 8-9.

Kuhn also acknowledges his misuse, not necessarily as a negative statement, of the traditional distinctions of "the context of discovery" and "the context of justification." In doing so, Kuhn is calling this traditional view into question. Are the elements of "the context of discovery" all sociological, historical, or psychological, while all the elements of "the context of justification" logical or philosophical. Is there a one-way street regarding procedures of justification from philosophy to science?

A point of criticism and possible solution to Kuhn's theory will be presented. Kuhn's theory will be criticized at the end of this chapter and a possible solution in chapter IV. For current purposes Kuhn acknowledges that there may be criticism of his work, since being an historical one, it is subject to the same criteria as theories in the natural sciences. This criticism relies on the nature of statements Kuhn makes in the theory. Are they arbitrary premises? Is Kuhn's theory nothing more than an arbitrary view that may or may not fit the data of the history of science? Does it fit only the data he examined in the formation of this hypothesis? Is it useful or true regarding other subject matter, at different times, and in different places and circumstances? The criticisms appear to be of some importance to Kuhn and their relevance will be addressed later.

From Normal Science to Revolution

The key areas of interest in the evaluation of Kuhn's work will be the process through which normal science leads to crisis and then to revolution. Of key interest is the mechanism through which scientific revolution occurs. Do anomalies just sort of add up, like cords of wood, or is their something external to the science that turns these anomalies into points of interest? What the science did not have to answer before now becomes of the most important interest. To examine these points and others, we will need to go into

greater detail regarding the process that leads from the practice of normal science into crises and eventually replacement of the dominant paradigm with a new one.

The existence of paradigms allows scientists to focus their energies on the solution of 'puzzles' supplied for it by the paradigm. The paradigm establishes the types of puzzles to be solved and the method about which to solve these puzzles. Kuhn accepts that things can be scientific if they are governed by commonly accepted scientific methods. That it is the commonly accepted principles at any one time that determine what is scientific, rather than some universal, or contemporary standard.

Kuhn begins by discussing the definition of paradigm as an "accepted model or pattern . . . But it will be shortly clear that the sense of 'model' and 'pattern' that permits the appropriation is not quite the one usual in defining paradigm."[19] Kuhn relates a paradigm as it stands in relation to a science in the way that a common law decision is to law. A decision in a common law case is "an object for further articulation and specification under new or more stringent decisions."[20] The act of working within a paradigm is normal science; something Kuhn attributes in large part is to solving puzzles supplied by the paradigm. The paradigm supplies the underlying metaphysical beliefs, the legitimate subject matter, expected results, and the rules for solving puzzles.

The route to normal science is said to begin when a group of practitioners within a field accept a paradigm. Practitioners, prior to paradigm acceptance, disagree considerably as to the metaphysical nature of the phenomena they study, as well as to what constitutes something worth studying and how it should relate to other things. Only

[19] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 23.
[20]Ibid.

when a paradigm is accepted, in the early stages supplied in the form of classics, can practitioners begin the work of normal science. One can see benefits to the acceptance of a paradigm by scientists. The acceptance of a paradigm reduces the amount of time and energy spent on coming up with answers to, and defenses of metaphysical and methodological questions. It provides a framework, with a vocabulary, through which practitioners can communicate their findings. It sets the limits of acceptable scientific study, the methods one must use to make discoveries, and provides the scientific community, that accepts it, with a range of expectations on what one should find. Kuhn defines normal science as follows, " In this essay, 'normal science' means research firmly based upon one or more past scientific achievements, achievements that some scientific community recognizes for a time as supplying the foundation for its further practice."[21]

Only after these methodological and metaphysical questions have been answered can scientists begin observing and relating phenomena within their field. In the absence of pre-established theory, scientist cannot interpret events. The paradigm supplies an incomplete research program through which to accomplish the puzzle solving done by the bulk of scientists during times of normal science. Kuhn points out; "One of the reasons normal science seems to progress so rapidly is that its practitioners concentrate on problems that only their own lack of ingenuity should keep them from solving."[22]

[21] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 10.
[22] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 37.

"To be accepted as a paradigm, a theory must seem better than its competitors, but it need not, and in fact never does, explain all the facts with which it can be confronted."[23] This interesting passage says a few things of importance. One, a theory that explained all of the facts with which it could be confronted with would leave no room for additional work. There would be no puzzles for puzzle solving scientists to solve. The second point is that a paradigm must seem 'better' to those who accept it. This point Kuhn leaves a bit wanting throughout the book. What does better mean? Could it be some sort of metaphysical meaning, that somehow certain paradigms are objectively better than others are? This is clearly not the case, as we will discuss later, Kuhn does not believe that there is a universal standard by which paradigms can be judged. Could it merely be aesthetic personal preference? I prefer A paradigm to B paradigm thus I chose A? This would not seem to work in accordance with Kuhn's ideas. What it is that makes a paradigm better than its predecessor or competitors will be evaluated later in the chapter? This problem is one with which Kuhn's metaphysical beliefs seem to have a problem determining, he does however make a point at the end of the book in which he says

> The analogy that relates the evolution of organisms to the evolution of scientific ideas can easily be pushed to far. But with respect to issues of this closing section it is very nearly perfect. The process described in section XII as the resolution of revolutions is the selection by conflict within the scientific community of the fittest way to practice future science. The net result of a sequence of such revolutionary selections, separated by periods of normal research, is the wonderfully adapted set of instruments we call modern scientific knowledge. Successive stages in that developmental process are marked by an increase in articulation and specialization. And the entire process may have occurred, as we now suppose biological evolution did, without benefit of a set goal, a permanent fixed scientific truth, of which each stage in the development of scientific knowledge is a better exemplar.
>
> Anyone who has followed the argument this far will nevertheless feel the need to ask why the evolutionary process should work. What must nature, including man, be like in order that science be possible at all? Why should scientific communities be able to

[23] Ibid., p. 17-18.

> reach a firm consensus unattainable in other fields? Why should consensus endure across one paradigm change after another? And why should paradigm change invariably produce an instrument more perfect in any sense than those known before? From one point of view those questions, excepting the first, have already been answered. But from another they are as open as they were when this essay began. It is not only the scientific community that must be special. The world of which that community is a part must also posses quite special characteristics, and we are no closer than we were at the start to knowing what these must be. That problem –what the world must be like in order that man may know it? –was not, however, created by this essay. On the contrary, it is as old as science itself, and it remains unanswered. But it need not be answered in this place. Any conception of nature compatible with the growth of science by proof is compatible with the evolutionary view of science developed here. Since this view is also compatible with close observation of scientific life, there are strong arguments for employing it in attempts to solve the host of problems that still remain.[24]

Progress in science is a mystery to Kuhn. His problem may be in that he views science as some institution in isolation from the rest of human endeavors. A view, which we will conclude later, is in error. Science is an action. The products of scientific research are goods. Useful things that individuals, though maybe not the scientist, use in accomplishing goals that directly satisfy their needs, making it a consumer good or indirectly through their usefulness in the production of some capital good that in turn is useful in the production of consumer's goods.

This leads us to one further point covered in our review that is the incommensurability of various paradigms within a field. Kuhn notes that during scientific revolution that often the new paradigm is not translatable into the previous one. Terms are redefined, and concepts in a newer paradigm may have no place in the old. This leads him to conclude that paradigm shifts are not necessary advancements in knowledge.

> Successive paradigms tell us different things about the population of the universe and about that population's behavior. They differ, that is, about such questions as existence of sub-atomic particles, the materiality of light, and the conservation of heat or energy. These are substantive differences between successive paradigms, and they require no further illustration. But paradigms differ in more than substance, for they are directed not only to nature but also back upon the science that produced them. They are the source of the methods, problem-field, and standards of solutions accepted by any mature scientific community at any given time. As a result, the reception of a new

[24] Ibid., p. 172-173.

> paradigm often necessitates a redefinition of the corresponding science. Some old problems may be relegated to another science or declared "unscientific." Others that were previously non-existent or trivial may, with a new paradigm, become the very archetypes of significant scientific achievement. And as the problems change, so, often, does the standard that distinguishes a real scientific solution from mere metaphysical speculation, word game, or mathematical play. The normal-scientific tradition that emerges from a scientific revolution is not only incompatible but often actually incommensurable with that which has gone before.[25]

If one paradigm cannot be directly compared, from the historian of science's standpoint, then one cannot say whether one paradigm is better or worse than another. As such, the view of the Whig historians of thought is without grounds. Science cannot be an ever-present march towards true enlightenment, but rather an arbitrary thing. The acceptance of one paradigm over another is not an element of the logical subject of philosophy, but rather time and place dependent.

In total, Kuhn attacks the Whig theory of history, through incommensurability of past paradigms. He also portrays a view of scientific revolutions occurring as a result of anomalies within a paradigm that are suppressed during periods of normal science, but are somehow viewed at a different time as acute. This leads to times of competition between the older dominant paradigm and competitors. The same things that lead some scientists to accept an initial paradigm leads to paradigm shift. New entrants, importantly, and some old practitioners accept the new paradigm over the older one. "To be accepted as a paradigm, a theory must seem better than its competitors, but it need not, and in fact never does, explain all the facts with which it is confronted."[26] "When in the development

[25] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 103.

[26] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 17-18.

of a natural science, an individual or group first produces a synthesis able to attract most of the next generation's practitioners the older schools gradually disappear."[27]

Normal science is a puzzle-solving activity. Kuhn relates it to solving a jigsaw puzzle. The paradigm supplies the rules, permissible subject matter, and expectations of the results from investigation. During periods of normal science, scientists working within the framework of a paradigm, solve puzzles laid out for them through the confines of the paradigm. During such times, anomalies and things that should be explainable but cannot be explained through the paradigm always exist. At certain times, these anomalies lead to scientific revolution. When these anomalies go from being ignored, or put on the back burner, to becoming acute problems, this initiates the formation of rival paradigms.

Extraordinary science occurs when the foundations of paradigms are questioned and work is done to justify or contradict these foundations. During this period, the paradigm that is able to recruit a majority of new entrants to a field wins out in the battle. If this occurs, then the older paradigm is replaced by a newer paradigm. Kuhn admits that those who adopt it view this new paradigm as being better. Kuhn believes that this acceptance is based on "future promise" rather than "past achievement." However, "The man who embraces a new paradigm at an early stage must often do so in defiance of the evidence provided by problem solving. He must, that is, have faith that the new paradigm will succeed with the many large problems that confront it, knowing only that the older paradigm has failed with a few. A decision of that kind can only be made on faith."[28]

[27] Ibid., p. 18.
[28] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 157- 158.

We can put this into terms, not so value laden as Kuhn's, and call this act of faith judgment. The objects of paradigms discussed by Kuhn are problematic. We do not know for certain that the presuppositions of the paradigm are true. If these objects were directly or indirectly proven and thus known to us, then there would not be discussion on them. We could simply deduce theory from these synthetic statements. Instead, the problematic nature of some of the objects in physics, chemistry, biology and electrical sciences lead to a reliance on judgment if we are to get any expedient results out of these fields. Thus, while the paradigm shifts from one paradigm to another in these fields are problematic, they are not arbitrary either. They are the results of judgments, and in fact, could not be done in any other way. This is not the place to discuss the intricacies of this, but, the choices of Kuhn's observations are only of empirical sciences and as such, his work is skewed towards the problems and nature of the objects under those fields. He fails to investigate theories and paradigms associated with other fields such as the social sciences, and the more abstract sciences that make observation and measurement possible within the empirical sciences he examines.

A Reexamination of 'The Structure of Scientific Revolution.'

The purpose of this dissertation is to reexamine Thomas Kuhn's *The Structure of Scientific Revolution* and use the work in combination with the metaphysical, epistemological and ontological ideas outlined in chapter II. Upon doing so, Kuhn's theory will be reconstructed on synthetic grounds. In doing so some solutions to some of the problems associated with Kuhn's work will be proposed. These problems include the arbitrary nature of Kuhn's theory. If we applied Kuhn's standard on the arbitrary nature of paradigms and his declaration on the inability to distinguish progress in the physical

sciences to his own work, it would be difficult, absent a reconstruction, to claim anything more for it than the status of a scientific revolution in the history of science. Is Kuhn's theory any better than the Whig theory of history he tries to replace in the history of science? By placing Kuhn's theory on synthetic grounds, a claim of more than just the status of a scientific revolution can be made of this reconstructed theory. This would place it as a progression over the Whig theory rather than just a replacement whose acceptance is based on "an apparent arbitrary element compounded of personal and historical accident."[29]

Kuhn's failure to discuss metaphysics leads to problems in his work; another problem arises in relation to the application of his theory to itself. He fails to base any component of his system in relation to a necessary truth. His observations, while accurate, do not in any way necessitate his theoretical claims. Kuhn himself admits this on the last paragraph of the first chapter.

> Rather than being elementary logical or methodological distinctions, which would thus be prior to the analysis of scientific knowledge, they now seem integral parts of a traditional set of substantive answers to the very questions upon which they have been deployed. That circularity does not at all invalidate them. But it does make them parts of a theory and, by doing so, subjects them to the same scrutiny regularly applied to theories in other fields. If they are to have more than pure abstraction as their content, then that content must be discovered by observing them in application to the data they are meant to elucidate. How could history of science fail to be a source of phenomena to which theories about knowledge may be legitimately be asked to apply?[30]

While it may not be a criticism of Kuhn that his theory is no different from the theories he comments in his book as being arbitrary, it would be a stronger theory if it could be based on axiomatic grounds and deduced from them. How can a history of science deduced from facts then be used to explain those facts? This is what Kuhn

[29] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 4.
[30]Ibid., p. 8-9.

attempts to do. It would be a more advantageous position to be able to explain the empirical phenomena of scientific revolution from a theory based in fact, but facts separate yet related to the phenomena that one wishes to explain.

The use of the words knowledge, science and justification, when used by Kuhn, differ wildly from their philosophical usage. He uses the word scientific knowledge to discuss the theories of paradigms. If these theories are deduced from arbitrary premises that are chosen due to historical and personal accident, then how can the pronouncements made by them and their interpretations of empirical data be knowledge? Specifically if one paradigm replaces another, do those pronouncements of the previous paradigm go from being knowledge to non-knowledge? Kuhn in no place in his book makes the assertion that he believes the ontological truths of the physical sciences are altered over the course of time or space. In the absence of such a pronouncement, in fact, Kuhn does not make a pronouncement on truth; we can only be left with a relativistic view of the words truth, knowledge and science as arbitrary utterances. He does not even use the word truth except in quoting Bacon or denying that science brings us ever closer to the truth. In fact, if we cannot even determine their truthfulness, then how can Kuhn use the term knowledge in any sort of constructive way? In fact, his usage of the term throughout the book does not entail that a proposition is true, nor that the scientists who ‘discover’ theoretical insights are in a good position to assent to them (condition (i) and (iii) from the definition in chapter II). His position of the relationship between reality and the mind can only be that of an ignorance of any relation.

If science is not a process that discovers truths about the mind-independent or mind-dependent world there are serious problems. One, how would one distinguish the works of Newton, Einstein, or Kuhn from witchcraft, superstition, or alchemy? Now one must not say, that at all times, all scientists, or all paradigms discover truths. However, to say that they never do or that we cannot know that they do is a bit problematic. Kuhn's justification for these statements is that scientific paradigms are incommensurable. When one views scientific research, and the paradigms that are used to undertake it, from an outside view, an essentially economic one, incommensurability among the various paradigms of science is not a sign that they are incapable of being related to reality, truth, or progress.

Another issue in Kuhn's theory that will be addressed is his narrow range of choices in his study.

> For one thing, Kuhn's and Feyerabend's relativism surely cannot be extended to logic and protophysics. If one wants to make a meaningful proposition or any measurement at all, "anything" does *not* go. Such disciplines, which incidentally have remained largely outside the scope of Kuhn's and Feyerabend's considerations, are *absolutely* indispensable for *any* empirical science (and not merely irrefutable paradigms capable of substitution by other, incommensurable ones).[31]

Kuhn's choices of branches of science all fall within those branches that are empirical members of the physical sciences. He ignores the non-empirical sciences associated with protophysics as well as the social sciences. This leads to certain views regarding the development of science.

[31] Hans-Hermann Hoppe, *The Economics and Ethics of Private Property* (Boston: Kluwer Academic Publishers, 1993). P. 211.

Kuhn seems to see the physical sciences as the more developed and more general rule for science. This view will be considered in light of the methodological and epistemological discussions from chapter II. The inductive approach, if viewed as the only approach to science, can lead one to a nihilistic view. The scientific method does not justify propositions. Kuhn relates particular ideas regarding propositions to scientific paradigms as a whole. As noted earlier, Popper's view was that it could not refute them either, although his view of science relies of falsification. Only propositions that are falsifiable have meaning, however, the results of experiments preformed under the scientific method do not disprove theory. Kuhn acknowledged this,

> A very different approach to this whole network of problems has been developed by Karl R. Popper who denies the existence of any verification procedures at all. Instead, he emphasizes the importance of falsification, i.e., of the test that, because its outcome is negative, necessitates the rejection of an established theory. Clearly, the role thus attributed to falsification is much like the one this essay assigns to anomalous experiences, i.e., to experiences that, by evoking crises, prepare the way for a new theory. Nevertheless, anomalous experiences may not be identified with falsifying ones. Indeed, I doubt the latter exist. As have been repeatedly emphasized before, no theory ever solves all the puzzles with which it is confronted at a given time; nor are the solutions already achieved perfect. On the contrary, it is just the incompleteness and imperfection of the existing data-theory fit that, at any time, define many of the puzzles that characterize normal science. If any and every failure to fit were grounds for theory rejection, all theories ought to be rejected at all times. On the other hand, if only severe failure to fit justifies theory rejection, then the Popperians will require some criterion of "improbability" or a degree of falsification." In developing one they will almost certainly encounter the same network of difficulties that has haunted the advocates of the various probabilistic verification theories.[32]

Problems arise in a negative result from experimentation. A single result in the negative does not lead to the abandonment of a theory, nor should it. The results may be the result of variables not controlled, or known of, that affect the relationship being studied. Even if it were grounds to reject a theory, what would replace it? Kuhn explains that all sciences have anomalies that they cannot deal with. Any paradigm is incomplete,

[32] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 146-147.

the questions it attempts to answer are not known, otherwise the scientific activity would be of no novelty or use.

Human actors operating within the real world must have pre-established theories about how the world works. If they did not choose some theory, they could not act. In acting they choose some actions over others, and they choose some perceived causal connections over others they perceive to be less certain, or less efficient. Action, in the absence of pure theory, must rely on some incomplete theory, regardless of whether or not it is commensurable or incommensurable with others. The failure of a theory in one or some instances does not require the complete abandonment of it; rather it leaves the door open to new theories. When the importance of certain problems associated with scientific theory, as determined subjectively through preference rankings, increases the value of a solution increases, this tends to induce scientists to come up with a theory that solves important problems.

The issue of how science should be viewed is an issue that must be taken up. In viewing science as a closed community, Kuhn only focuses on those issues of acceptance for a paradigm from within the scientific community. This might be acceptable if the scientific community were a self-sufficient institution producing science only for its own consumption. However, the scientific community is not a closed, self-sufficient institution, the community as a whole receives the bulk of its funding from outside the scientific community. As such this funding depends on the scientific community's, whether the entire community, a particular field, or paradigm, ability to provide others with goods, in this case scientific theories, that satisfy the needs of the demanders of science.

Kuhn acknowledges this, but then puts it away on the back burner and focuses on issues internal to the scientific community as 'triggering' scientific revolution. When discussing the Copernican revolution, Kuhn writes the following

> Breakdown of the normal technical puzzle-solving activity is not, of course, the only ingredient of the astronomical crises that faced Copernicus. An extended treatment would also discuss the social pressure for calendar reform, a pressure that made the puzzle of precision particularly urgent. In addition, a fuller account would consider medieval criticism of Aristotle, the rise of Renaissance Neoplatonism, and other significant historical elements besides. But technical breakdown would still remain the core of the crises. In a mature science–and astronomy had become that in antiquity– external factors like those cited above are principally significant in determining the timing breakdown, the ease with which it can be recognized, and the area in which, because it is given particular attention, the breakdown first occurs. Though immensely important, issues of that sort are out of bounds for this essay.[33]

Kuhn acknowledges what we will be discussing later that science cannot be viewed in isolation from the rest of mankind. While we like to talk of the ivory tower, the ivory tower does not produce its own food, clothing, or support itself. Intellectuals rely on the production of non-intellectuals for their keep. In doing so, intellectuals must produce scientific or pseudo-scientific theories that in some way relate to making the lives of non-intellectuals better. When they do they are rewarded, when they do not they are not supported, and thus are no longer able to carry on their research under the support of others.[34]

Scientists produce scientific theories. Under the division of labor and specialization, they may not be the same persons who take these theories and turn them into technological ideas directed towards the pursuit of human needs, but the value of

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[33] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 146-147.

[34] The perception of non-intellectuals is important here. When they perceive that scientific research will help them accomplish previously impossible goals, or accomplish goals in a more expedient or more efficient manner, then this research has value. Since the results of the research come after the research, in determining whether of not to fund it those who support a particular research project rely on judgment. As with all matters of judgment, those supporting the research may be in error in doing so ex-post. They may also achieve the desired results ex-post as well.

their theories are based on their perceived relevance to future human needs. The end of all scientific theories used in the form of technological ideas is to provide cause and effect relationships that eventually lead to the production of a consumer good. These theories may be true or false; however, they must be viewed as being potentially useful in order that anyone pays for them.

The ends of science are what constitute the demand for it. In the case of an independent scholar, the end may be internal to the process. The independent scholar may just want to know. In this case, science is not produced for an external market, but rather for an internal one. The payment for his services may be the satisfaction in knowing something that he did not previously know. An additional end for science may be, for those who did not produce the theory to know it themselves. This takes the form of education. Individuals acquiring information about things they do not know from an individual who does know. The market for scientific thought then becomes external to those who know and produce them.[35] In this case, the educating of others may not increase the knowledge, or perceived knowledge of the discoverer, but does increase the well-being of others. In this case, the general rule, unless freely educating others is a goal of the intellectual, is that the educator is paid by the educated or some institution that has in its interest the dissemination of particular scientific ideas, or pseudo-scientific ideas to the educated. Businessmen may also sponsor scientific research perceiving potential usefulness of the research as technology for the eventual production of consumer goods. Future scientists also must achieve education as an intermediate goal leading to their future goal of performing of scientific research themselves.

[35] Even in the case that a particular scientific idea is true or not, others can still come to know the theory or paradigm.

Scientific theories, as ideas, are things that can be related to other things. Scientific theories are things that can be brought into causal connection with human needs. In cases where there is a perceived relationship between a scientific theory and a human need these theories acquire goods nature and as such value. The scientist himself may not know, or care about the proposed relationship to human needs. The scientist's research, if done for any other reasons but the self-satisfaction of knowing, is provided onto markets for ideas. He believes that by doing so he will be able to acquire other market goods that will satisfy his own needs. There is a supply and a demand for scientific theories. This demand is based on the perceived usefulness of science in achieving human ends.

In the satisfaction of human ends, men will always prefer the satisfaction of a need sooner rather than later. If one had to wait for physicists to come up with a satisfactory theory that deduced the theories of the universe from basic a priori premises, assuming there are some, we would die. In preferring the satisfaction of ends sooner rather than later, this puts the issue of expediency at issue, we are forced to rely on less than complete theories, where complete theories do not exist, to obtain the satisfaction of our ends. Thus, while a theory may not be true, it can be accepted as useful. In cases where the objects under consideration are problematic objects, or relationships, we must rely on the empirical sciences to produce incomplete theories and, it is possible, theories that they may well be incommensurable with prior theories. This new theory is required to produce results sooner, rather than later. In some cases, absolute knowledge may never be possible. This is not an issue, as we have stated in chapter 2. We cannot know everything about a mind-independent reality or ourselves for that matter, but we can

know some things. When propositions can be proven through direct proof, experience, such as there is writing on this page, or through indirect proof then they become known. In the case of problematic objects, those in which suggested attributes are not determined to coalesce or not coalesce, we must rely on judgment.

In not addressing these issues Kuhn's work is lead into certain problems. One, his theory, in being based on history, is susceptible to the same criteria and judgments of arbitrariness as the theories he examines. He continually misuses the words science, and knowledge, and never defines the word truth throughout the book. His ideas that theories that are not commensurable must indicate a lack of the ability to determine progress in a science are problematic when viewed through the framework of them being useful in the achievement of human needs. The following quote from Hans-Hermann Hoppe explains this problem.

> Yet even when all is said, rationalism's claims are not affected in the least. For one thing, Kuhn's and Feyerabend's relativism surely cannot be extended to logic and protophysics. If one wants to make a meaningful proposition or any measurement at all, "anything" does *not* go. Such disciplines, which largely remain outside the scope of Kuhn's and Feyerabend's considerations, are *absolutely* indispensable for *any* empirical science (and not merely irrefutable paradigm's capable of substitution other, incommensurable ones). However, once this is recognized, and once it is understood that proposition-making, counting, the construction of measurement instruments, and measuring, all of which make the empirical natural sciences possible, are purposeful activities, it immediately becomes clear that the paradigms of the natural sciences must be conceived as a means towards some universal indispensable human end, that they must be commensurable as regards their efficiency in attaining this end.
> The relativistic impression of the development of the empirical sciences that Kuhn and Feyerabend try to convey is due to the fact that they both misconceive of scientific theories as mere systems of verbal propositions and systematically ignore their foundation in the reality of action. Only if one regards theories as being completely detached from action does any theory not only become immunizable, but any two rival theories whose representative terms cannot be reduced to and defined in terms of each other then appear completely incommensurable so as to exclude any rational choice between them. However, this affects neither the refutability of any one theory, nor the commensurability of rival paradigms, on the entirely different level of applying them in the reality of action, of using them as instruments for the attainment of a practical purpose. [3637]

[36] Hans-Hermann Hoppe, *The Economics and Ethics of Private Property* (Boston: Kluwer Academic Publishers, 1993). P. 211-212. In ff. 1., Hoppe citing P. Lorenzen, *Normative Logic and Ethics* (Mannheim: Bibliographisches Institut, 1969) defines protophysics as "Geometry, chronometry and

Kuhn's views on science, and progress within it, are clouded by a failure to incorporate philosophical views that enable one to truly come up with a theory that relies on synthetic foundations. As such, his theory is weakened by the absence of such justifiable claims. The criticisms or inadequate properties that he ascribes to other paradigms are also applicable to his theory on scientific revolution. This is due to the absence of a philosophical anchoring in true, irrefutable statements. His emphasis on the physical empirical sciences as the most developed and general cases for science as a whole is misleading, in *The Structure of Scientific Revolutions*, Kuhn fails to take issue with protophysics and other *a priori* sciences that make the empirical sciences possible. His focus on internal causes of paradigm acceptance and, through this, revolution result in a problem with determining what it is that actually triggers scientific revolution.[38]

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hylometry [rational mechanics] are a-priori theories which make empirical measurement of space, time and materia 'possible.' They have to be established before physics in the modern sense of an empirical science, with its hypothetical fields of forces, can begin. Therefore, I should like to call these three disciplines by the common name: *protophysics*. The true sentences of protophysics are those sentences which are defendable on the basis of logic, arithmetic and analysis, definitions *and* the ideal norms which make measurement possible." P.60.

[37] When it comes to the usefulness of paradigms, their usefulness can change over time in accordance with a change in goals of human actors, a change in the institutional framework within which scientific research is undertaken, or sociological factors. Changes in laws and or distribution of scientific research funding can result in changes in paradigms. While the paradigms under consideration at any one time may be flawed in their practicality, the choice as to which flaws to accept can change with changes in the ends chosen by a large number of human actors, institutional changes, or sociological changes. A simple example of the later might be changes in religious views or doctrines. The rise of new institutions replacing older ones that were favorable to an older paradigm's conclusions could also trigger a change in paradigms. In the end all changes can be attributable to changes in the mentality of a large portion of the population. These result in changes in actor's ends, and result in institutional and sociological change.

[38] Kuhn does acknowledge sociological and economic factors in later works. However, he is hodgepodge in his acceptance of them. His later works also open up a variance of differing views and paradigms as to what causes scientific revolution. While it is not my intention to address all of Kuhn's work, since this would be both problematic and unnecessary. Kuhn's *The Structure of Scientific Revolutions* is being criticized and used as a foundation for applying the concepts of Chapter II to construct an economic view of scientific revolution with what is salvageable in *The Structure of Scientific Revolutions*.

> A rather different influence on social science was Kuhn's influence on the development of social studies of science itself, in particular the 'Sociology of Scientific Knowledge'. A central claim of Kuhn's work is that scientists do not make their judgments as the result of consciously or unconsciously following rules. Their judgments are nonetheless tightly constrained during normal science by the example of the guiding paradigm. During a revolution they are released from these constraints (though not completely). Consequently

there is a gap left for other factors to explain scientific judgments. Kuhn himself suggests in *The Structure of Scientific Revolutions* that Sun worship may have made Kepler a Copernican and that in other cases, facts about an individual's life history, personality or even nationality and reputation may play a role (1962/70a, 152-3). Later Kuhn repeated the point, with the additional examples of German Romanticism, which disposed certain scientists to recognize and accept energy conservation, and British social thought which enabled acceptance of Darwinism (1977c, 325). Such suggestions were taken up as providing an opportunity for a new kind of study of science, showing how social and political factors external to science influence the outcome of scientific debates. In what has become known as social constructivism/constructionism (e.g. Pickering 1984) this influence is taken to be central, not marginal, and to extend to the very content of accepted theories. Kuhn's claim and its exploitation can be seen as analogous to or even an instance of the exploitation of the (alleged) underdetermination of theory by evidence (c.f. Kuhn 1992, 7). Feminists and social theorists (e.g. Nelson 1993) have argued that the fact that the evidence, or, in Kuhn's case, the shared values of science, do not fix a single choice of theory, allows external factors to determine the final outcome (see Martin 1991 and Schiebinger 1999 for feminist social constructivism). Furthermore, the fact that Kuhn identified *values* as what guide judgment opens up the possibility that scientists ought to employ different values, as has been argued by feminist and post-colonial writers (e.g. Longino 1994).

Kuhn himself, however, showed only limited sympathy for such developments. In his "The Trouble with the Historical Philosophy of Science" (1992) Kuhn derides those who (including the proponents of the Strong Programme in the Sociology of Scientific Knowledge) take the view that in the 'negotiations' that determine the accepted outcome of an experiment or its theoretical significance, *all* that counts are the interests and power relations among the participants. Even if this is not entirely fair to the Strong Programme, it reflects Kuhn's own view that the primary determinants of the outcome of a scientific episode are to be found within science. First, the five values Kuhn ascribes to all science are in his view constitutive of science. An enterprise could have different values but it would not be science (1977c, 331; 1993, 338). Secondly, when a scientist is influenced by individual or other factors in applying these values or in coming to a judgment when these values are not decisive, those influencing factors will typically themselves come from within science (especially in modern, professionalized science). Personality may play a role in the acceptance of a theory, because, for example, one scientist is more risk-averse than another (1977c, 325)—but that is still a relationship to the scientific evidence. Even when reputation plays a part, it is typically *scientific* reputation that encourages the community to back the opinion of an eminent scientist. Thirdly, in a large community such variable factors will tend to cancel out. Kuhn supposes that individual differences are normally distributed and that a judgment corresponding to the mean of the distribution will also correspond to the judgment that would, hypothetically, be demanded by the rules of scientific method, as traditionally conceived (1977c, 333). Moreover, the existence of differences of response within the leeway provided by shared values is crucial to science, since it permits "rational men to disagree" (1977c, 332) and thus to commit themselves to rival theories. Thus the looseness of values and the differences they permit "may . . . appear an indispensable means of spreading the risk which the introduction or support of novelty always entails" From Unknown Author, Thomas S. Kuhn, http://plato.stanford.edu/entries/thomas-kuhn/#6.1, April, 7, 12006.

CHAPTER IV: RECONSTRUCTION OF KUHN

The bulk of the work laid out in this chapter has been presented in chapters II and III. The methodological and epistemological foundations have been laid out in chapter II. The process of scientific revolution put forward by Thomas S. Kuhn in *The Structure of Scientific Revolution*, and problems with his work are presented in chapter III. The problems in chapter III were presented as follows

1) Kuhn's theory, in being a historical one, is susceptible to the very same types of criticism as those that he investigates. The theory, in not being anchored on necessary premises, is based on analytic a priori premises, and thus susceptible to the criticism of being arbitrary. By Kuhn's very own criteria, we cannot view his theory as being commensurable or an improvement over the Whig Theory his work is a substitute for.
2) His argument by admission is circular.[1]
3) Kuhn's misuse of the words science and knowledge and his absence of a definition for the word truth. Kuhn only uses the word truth in disclaiming the existence of progress in science. This misuse and absence of a definition for his terms based in truth, fail to distinguish scientific activity from those of superstition, myth, witchcraft or alchemy.
4) Kuhn's examination only includes examples from the empirical physical sciences. He fails to address the synthetic *a priori* sciences of protophysics upon which the measurements and observations of the empirical physical sciences are made possible.

Kuhn also adheres to the view that the empirical physical sciences are the more general and developed forms of science. As such, their examples and problems are present in all the sciences.

5) Kuhn views scientific paradigm acceptance and rejection as being internal to the scientific community. This results in him being unable to describe the crises and thus the trigger for scientific revolution as more than the adding up of anomalies. In Kuhn's defense, he does note that external factors may be valuable in determining the timing of such revolutions, but that external factors were outside the bounds of his essay.

The Road to a Reconstruction

The reconstruction of Kuhn's theory will address all of these problems. Chapter II has presented the metaphysical and epistemological basis upon which this reconstruction will take place. We can differentiate the sciences based upon the nature of the objects they examine and the methods under which knowledge may be gained about them. The reconstruction will be based on necessary truths. These truths are indirectly proven, in that they cannot be negated without their own use being a part of the attempted refutation. They are known through the reflective process, in this case being social phenomena through psychological reflection.

The words, *truth*, *reality* and *science* have been discussed in chapter II as well. Truth is divided into three types. A "Logical Truth is the identity of what is assented to with reality. A man possesses logical truth when what he assents to is a reality. An ontological truth is a reality which can be assented to or a reality which can be known. A

[1] Kuhn, Thomas, S., *The Structure of Scientific Revolutions*, (Chicago: The University of Chicago Press, 1962). P. 8-9.

Moral truth is the identity of what is said with what is assented to. It is the identity of what is said about a thing with what is thought about it."[2] "A *reality* or a *real object* is one which is made up of elements or attributes which coalesce into unity that is, into one object. To put it more accurately and concretely, a reality is an object which is such and such and such . . ."[3]

The conditions of knowledge have been presented in chapter II as well. "There is a fairly general agreement that the following are necessary and sufficient conditions of X's knowledge that p. (I) p must be true. (ii) X must believe that p, in the sense that he sincerely asserts, or is ready to assert, that p. (iii) X must be in a position to know that *p*."[4] The existence of ontological truths has been defended, and finally a discussion of what it means to say that 'X must be in a position to know that p' was undertaken. In the event that we experience things, we can call this knowledge synthetic *a posteriori*. These types of propositions can be proven directly.

> We have direct proof of a reality by reasoning from immediate perceptions of the mind or of the senses or from testimony of rational beings or from all combined. Thus, we have direct proof of many theorems in geometry and of the motion of the earth around the sun. We have indirect proof of the reality of a thing by showing that to suppose it to be unreal would involve a person in a contradiction.[5]

In the case where we can come to know of something through reflection, we come to know of these things indirectly. Indirectly we know that a ball cannot be both red and non-red all over at the same time, or that all men must act. In the first case, we learn this through ontological reflection and in the second case through psychological reflection.

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[2] John J. Toohey, S.J. *Notes on epistemology* (Origin of manuscript unknown). P. 4-5.
[3] John J. Toohey, "Reality and Truth," *The Philosophical Review*, v. 48, issue 5 (Sep., 1939), p, 493-494.

[4] Anthony Flew, *A Dictionary of Philosophy, Revised Second Edition* (New York: St. Martins Press, 1984) p. 194.
[5] John J. Toohey, S.J., *Notes on Epistemology* (Ann Arbor, Mich., Edwards Brothers inc., 1946). P. 18.

These definitions and the epistemological and metaphysical views expressed in chapter II are of the utmost importance. They are the basis upon which the theory of scientific revolution to follow is based. It will be necessary to defend the starting points of this theory as necessary. By doing so, the reconstructed theory of scientific revolution will not be susceptible to the criticisms that are presented against Kuhn's original theory. In the first place, this theory will not be an historical one and thus not susceptible to being arbitrary. In the second place, this reconstructed theory, by basing the theory on necessary facts; the charge of circularity implicit in Kuhn's historical theory will be eliminated. Thirdly, by defining the words, truth, reality and science these terms will be used in a coherent way. Sciences can be divided in accordance with the nature of the phenomena described by their assumptions. In the case of a theory based on indirect and thus necessary propositions, they are indirectly proven and thus synthetic a priori theories. True knowledge and true science are the cases where these sciences are performed correctly.

In the case where we are dealing with problematic objects as a foundation for theory, this theory cannot be known to be true. One is not in a good position to know these propositions. "Incomplete science"[6] derived from these propositions are matters of judgment to the degree that they rely on propositions on which judgment is the only recourse to their ability to be assented to. The sciences that Kuhn examines fit into this category. The presuppositions of these incomplete sciences are problematic objects. Their acceptance is based on judgment not proof. The application of the scientific method in the presence of problematic "incomplete scientific theories" performed in these empirical

[6] The phrase 'incomplete science' is used to distinguish the judgmentally validated theories of imperfect science from those of complete science deduced from necessary premises.

physical sciences does not prove the theories. At best, it can only fail to provide evidence to reject them. As Kuhn, and Popper note, the scientific method is also problematic if it is viewed as being capable of rejecting theory. The continued existence of positive results can only increase confidence in the results occurring in accordance with the theories being tested. However, this confidence is a subjective criterion and is problematic if one wants to set a standard regarding the level of confidence required in justifying or falsifying a theory.[7]

True science can only be derived from axiomatic premises, the defense of which was derived in chapter II. From true premises, using correct logic, we can come to true propositions about reality, whether it is a mind-dependent or mind-independent reality. This is not to say we have a complete list of axioms, or that we are capable of discovering all the necessary truths to explain every aspect of reality. It is only put forward that man can come to know, and in fact does know some necessary axiomatic propositions.

Any scientific research, or paradigm, whether it is complete, or incomplete, is an activity. When discussing normal science Kuhn equates it to puzzle solving, that is, an activity. The acceptance of a paradigm, scientific research and theorizing must be viewed as an action, and thus under the category of the social sciences.

It is true that science is not totally governed by logic and philosophy. Neither logic, nor philosophy has ever physically prevented anyone from accepting a theory or paradigm. Only individuals determine whether they will assent to a given paradigm. As an action, science, like any other action, is performed based on a perceived relationship between it and the accomplishment of some human need. All actions are directed towards

[7] See Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press,1962). P. 144-148.

the satisfaction of some human need. Scientific research is an action. Scientific paradigms are an intermediate goal towards the accomplishment of normal science. Thus, all paradigm formation and acceptance are driven by the perceived accomplishment of some future human need.

Finally, in viewing scientific research and paradigm acceptance as an action motivations for such actions and the particular ends they are directed at constitute demand for science. In the case of the independent gentleman scientist, common prior to the 1800s, his market could be an extremely small one. If his goal were simply to know something regarding a subject, he could simply undertake scientific research for his own end to know. In this case, the market for scientific research would be self-contained and isolated from the market. Paradigm choice could be seen as being in isolation from the needs and actions of others. Provided the research was self funded, performed in isolation and not presented to others, then we could say that science was completely, or close to completely isolated from other individuals, markets, and other human needs. Scientific research and paradigm choice performed by an enlightened hermit with no concern for others would be isolated from society, and other human needs. It would be an internal process in terms of scientific goals and paradigm acceptance. The hermit scientist would choose particular matters to investigate and his metaphysical beliefs. His conclusions would only be of value to himself. The other interesting characteristic of this would be that historians of science would have nothing to examine. In having no desire to communicate this knowledge, our hermit scientist would leave no records, no papers, or students to study. His work would not be a contribution, unless someone discovers his notes, or papers in defiance of his wishes.

When historians of science study the works of scientists, they are generally the works of individuals engaged in a market for ideas. These markets include education, the exchange of ideas for pay. Academic journals are exchanges between scientists and the journals for written research in exchange for at least an audience of scientists. Scientists who publish their work may do so for the benefit of their fellow man. They do so in the hope that others will find practical uses for their ideas, to increase their level of prestige within the scientific community as a whole, or in part, to receive merit pay or tenure at a university or research institution, or many other reasons. In doing so, they supply science to others for an anticipated reward. It is possible that research may not be received as intended; however, they produce this research under the belief that they will receive certain physical or psychic goods in return.

Thus in these cases and others, scientists are supplying ideas on markets. In doing so, they provide goods and services onto idea markets under the belief that they will receive certain psychic, or physical goods in return. The demanders of science include students, other scientists, universities, research institutions, academic journals, and their readers, entrepreneurs, and governments. Science is produced and bought on markets, these markets may be imperfect but they do exist, they may be free, or under heavy intervention. Science may be produced in the hopes of receiving financial rewards, such as merit pay. It may be produced in the hopes of receiving psychic rewards such as respect, prestige or acknowledgement for brilliance. In all of the cases where science is communicated, or directly used, it is a good that is supplied and demanded in markets.

The objects that can be studied and explained by historians of science are almost completely scientific ideas exchanged in scientific markets. Other than the rare instance where the hermit gentleman scholar's notes and private calculations were found, could we say that the objects available to historians of science were not supplied on markets? Most of what the history of science researcher has to examine is supplied onto a market. This is not to say that supply creates its own demand, just that it must have been supplied under the belief, at least, that there was some demand for it. Error is possible.

The needs of human beings are vital to the support and direction toward which scientific research is performed. The scientific community, especially in today's world, is highly dependent on demanders of scientific research. This includes consumer demands, producer demands and governmental demands for science.

Science as a Good

It has been put forward earlier that science is an action. Scientific activity is always driven to the satisfaction of some end. In being a thing useful in the accomplishment of ends, under certain conditions, science qualifies as a good.

> If a thing is to become a good, or in other words, if it to acquire goods-character, all four prerequisites must be simultaneously present:
> 1. A human need
> 2. Such properties as render the thing capable of being brought into a causal connection with the satisfaction of this need.
> 3. Human knowledge of this causal connection.
> 4. Command of the thing sufficient to direct it to the satisfaction of the need.[8]

As discussed in chapter II scientific ideas can posses this nature. In discovering things, their natures and the relationships between things, science both is an action and its research, for it to be useful must also be directed towards satisfying some human need.

[8] Carl Menger, *Principles of Economics*, trans., James Dingwall and Bert Hoselitz (Grove City, Pa.: Libertarian press, Inc, 1994). P. 52-53.

Those needs can be within the scientific community, such as I want to know such and such a thing, or I want my colleagues in the community to know such and such. However, the bulk of scientific research is geared to the satisfaction of human needs outside the community. When this is the case, science is supplied onto the market for ideas. Ideas are exchanged on a market that has demanders, government, entrepreneurs, consumers, and students; and suppliers, scientists in colleges and universities, at research institutes, and government bureaus.

As such, the motivational reason for scientific research is to eventually produce research that can be used to eventually produce a consumer's good. That good may be self-satisfaction in knowing, the use of scientific research to produce a technology that leads to the eventual production of a consumer good, or persuasion. We could think of an endless number of examples where scientific research has lead to the accomplishment of some goal. Scientific research can lead to the production of a good previously not possible, in the event of nuclear power from physics, or the production of some preexisting good under more expedient or more efficient conditions. Scientific research can also produce knowledge, or be used as a persuasive tool to persuade another individual or group into accepting a position they were reluctant to accept prior to the research becoming known.

To be a good, science must be useful. If it losses this capability to be brought into causal connection with some human need, it will lose its goods character. To be produced, it must be viewed as being potentially useful. The production of scientific ideas and paradigms is not solely driven by the scientific community, but also by demands placed on it by demanders outside the scientific community. When science fails

to produce theories that are viewed as being capable of being brought into causal connection with human needs outside the scientific community, it loses the support of external demanders. These external demanders are those who exchange money directly and the goods and services necessary to sustain the scientist, his standard of living and his research.

An additional characteristic of scientific knowledge is that it can be far from consumption in the structure of production. The structure of production is the time period during which the production of consumer goods takes place from the beginning of the process until the goods are consumed. Only in being consumed, do the goods make any one directly better off. Only in consuming a good, or part of a good in the case of consumer durables, can utility be achieved through the satisfaction of human needs. Being far from the actual consumption of goods produced using it, scientific ideas produced from paradigms in science are factors of production that incur a great deal of uncertainty when discounting the present value of some research. There are a large number of other accomplishments that must occur for scientific research to go from the drawing board to the dinner table. In between scientific research and consumption, the idea must be related to human needs. Technological implementation of the research must be developed. The savings necessary to complete the purchasing of factors of production must be available. The production of capital goods must be accomplished, and finally the transportation and marketing of the good are all prior to consumption. The number of individuals with roles in this process is increased as societies advance, markets grow and the division of labor and specialization are expanded.

This process has a two-fold effect on science and progress. As noted earlier, Carl Menger says that as civilizations advance the number of true goods expands and the number of imaginary goods, or errors, decreases. This applies to science as well. In addition, due to specialization, the scientist himself may not be involved in any process other than the production of scientific research. His product and the direction of his research may only be directed towards the demands of those collecting scientific research and relating it to human needs. These needs may be consumer needs, in which case the research is closely related to human needs, or towards the production of capital goods that are indirectly useful to the satisfaction of human needs. A special case would be demand related to the production of government, or public goods.

Governments are collections of individuals. The use of the term government in no way entails an entity outside of a collection of individuals exercising coercive monopolistic control over a geographic area. Government is an institution that claims the monopolistic right of coercion. Only government officials may initiate the first use of force, or penalize others for doing do. A basic feature of government is taxation. Governments engage in the extraction of money from market participants under the threat of force. Governments receive the bulk of their revenues from taxation, or some variant of it, such as seigniorage.

They then produce goods and services that are generally provided with no user fees, or user fees insufficient to cover the money costs of providing the good or service. In terms of economic calculation, the revenues are obtained in advance of the provision of goods and services. Revenues are not collected in relation to voluntary willingness to pay for the services provided, but rather by consent of the governed to be taxed. The

consent of the governed includes those who choose to pay in the presence of force and those who might be willing to pay if force were not backing up the charge.

As we will see later, government goods do not meet the market test for other goods and services. On the free market, goods command what others are willing to pay for them. If these goods are not perceived as being useful to the individuals who must pay for them, then they are not purchased. If on the other hand goods are viewed as being useful and then prove not to be, this does not undo the previous exchange, but has repercussions on future exchanges. In the case of government goods, this is not the case. The goods are already paid for by the taxpayers in advance and in no relationship to their usefulness and relative value to other uses of the resources that went in to producing them on behalf of taxpayers. These calculation problems will be discussed later in the discussion. The effects of government needs for estimates of the value of non-market goods, as planning and justification tools for their projects and policies, on economics is critical when the size and scope of government reaches significant proportions. As government increases in size and relation to the market, it places differing demands on economics, in placing a preference on theories that can satisfy its needs for forecasting and valuation of non-market goods and demands for them.

Demanders of Science

The demanders of science include consumers, entrepreneurs, politicians, government bureaucrats and those who wish to influence government officials, and the public. Consumers demand scientific research and theories to satisfy needs that as of yet have gone unmet, to satisfy their needs more efficiently and, or for expediency in satisfying needs. Entrepreneurs demand scientific research and theories to produce capital

and consumer goods that did not previously exist. Scientific research and theories are also useful in producing goods in a more expedient and, or efficient manner. Science is also useful to entrepreneurs in convincing others of the usefulness of their products, to persuade other owners of the possibility and profitability of projects and to improve their knowledge about their businesses and procedures. Governments also demand scientific research and theories to produce previously non-existent government goods such as the nuclear bomb and space flight. Science is useful to government in providing alternative methods of producing previously produced government goods and in ways to organize their production. Science can provide justifications for government policies and provide procedural information.

Government as Demander of Science

Government officials are large demanders of science. They value scientific research and theories for many different reasons. There reasons include developing technologies necessary to produce new public goods,[9] to produce public goods in a different manner, either more or less efficiently, or to produce public goods in a more, or less expedient fashion. It may seem odd that a government official would want to come up with a technology that made the production of a good less efficient, or less expedient, but it could be at certain times beneficial to the official personally to do so. This is not to say that they always do prefer these sorts of options, only that they may.

Governments also demand technology derived from scientific research to evaluate the value of non-market goods and services. This aspect of the government demand for scientific research and estimates will come heavily into play when we discuss the rise of

mathematical economics in the United States. Government taxes its citizenry. In taxing, its power to collect taxes is not dependent on its success in satisfying human needs, but rather limited by the consent of the governed to be taxed and the effect of its coercive powers.[10]

Government officials then produce and supply public goods to its citizens. In supplying these goods, some such as national defense, police and fire services, certain roads and others are supplied at a zero user cost. As such, in these instances governments cannot perform economic calculation. They cannot assess the value of the public goods provided, as no one pays directly for them. In the absence of direct user fees, government officials lose the ability to determine if the value of the good exceeds its cost. Is the good more valuable than its inputs? In addition, improvements to a public good cannot be directly valued. What is it worth to improve such and such public good? The value added by an improvement cannot be determined as no one pays, or in this case pays extra amounts for the improved good directly. Governments need estimates for the value of public goods and their improvements to determine if the social returns to a public good exceed its cost. The estimates are useful in determining which public goods are more important than others are.

Since governments already have collected the revenues for their projects, one may ask, why would they care if the value of the public goods were an increase in value over the inputs that went into it, or if some public goods provide a greater degree of satisfaction than others do? The reason for such concern could be benevolent, or not.

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[9] The word public good is used here to denote any good that governments choose to produce, either exclusively or non-exclusively. We are not using this word in the economic sense of a good that displays the characteristics of non-rivalrous consumption, and non-excludability.

Governments rule by consent of the governed. The bulk of modern governments are not run by omnipotent single dictators, but rather by groups of people, it becomes necessary to persuade fellow co-rulers of the benefits of government actions. These co-rulers in a democracy include voters, and the loyalty of those who carry out their rulings. In the absence of democracy, the rulers must maintain the tacit consent of the ruled and the loyalty of those who carry out their rulings.

In maintaining the consent of the governed, governments must justify their actions. To demonstrate, through the use of scientific research, the efficiency, or expediency of the production of public goods publicly, rather than privately on the market, is one way of justifying the production of these goods publicly. If this justification comes from scientific research, then it can be viewed as objective and valid. For the research behind such pronouncements to be judged scientific and objective it must be the result of research performed under some respectable, and, as we will show later dominant, or widely accepted paradigm. Sciences that produce results that can be used to justify government provision of public goods are more favorable to government officials, all other things being equal, than one that does not.

As noted earlier, governments cannot perform economic calculations regarding the benefit provided by their goods and services relative to their opportunity costs. The revenues of government are disassociated with the value they ultimately provide to consumers. Revenues are the result of taxation and not willingness to pay on behalf of the consumers of government produced goods and services. In some cases, such as national defense, courts, and others, government may be a monopolist. There is no market value

[10] See, Étienne de la Boétie, *The Politics of Obedience: The Discourse on Voluntarty* Servitude, Trans. Harry Kurz (New York: Free Life Editions, 1975). Also, Bertrand De Jouvenal, *On Power:It's Nature and*

for its output. A question remains, is what government produces beneficial to the taxpayers, and others whose consent, be it tacit consent or more, it is dependent upon to govern? In the absence of market prices there is no answer to this question, at least in the affirmative. In addition, where government produces goods internally, are there better or faster methods in which the good can be produced at a lower cost, or with a greater benefit? These types of questions cannot be answered in the same manner a business operating on the free market producing a single, non-vertically integrated product, can answer them. Profit and Loss is the businessman's solution to this problem. Governments cannot compare revenues and costs, since the revenues are disassociated with the benefits to those who pay for them. Estimates of the value of public goods are a need that governments have. This information can be useful in the running of the state and in justifying its continued production of public goods. Science can provide rationales for the operation, policies and projects of the state.

Businessmen as Demanders of Science

Business activities also rely on science to produce research capable of being turned into technology in the production of goods and services. This research may be useful in the development of technologies to produce goods previously not producible under current technology. Firms may also demand scientific research that allows for the development of currently produced goods and services under more efficient or more expedient processes. This may include the development of technologies that lead to the production of improved capital goods, information systems, processes, or using previously unused resources. It may be the improvement of organization techniques, or

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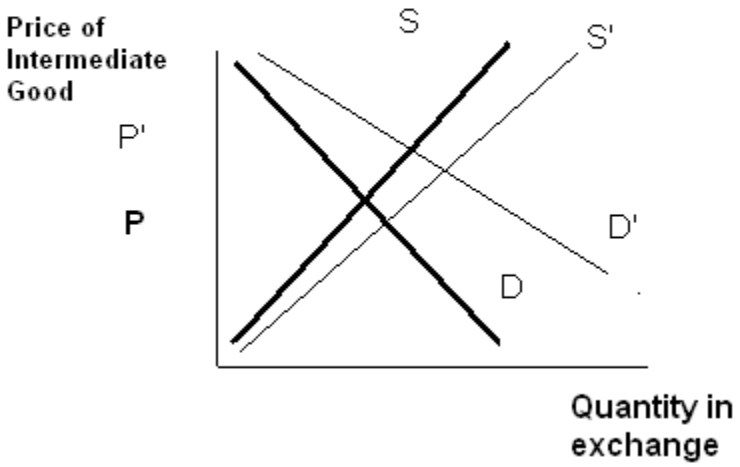
the History of ItsGrowth, Trans. J.F. Huntington (Westport, Conn.: Greenwood Press, 1981).

management techniques. In this case, assuming no change in the nature of the output, costs are reduced, and profits increased.

Figure 4-1.

The Supply and demand schedules for the counterfactual between a firm producing an intermediate good internally or purchasing it from a market



The supply and demand schedules above depict two possibilities. The heavier supply and demand schedules (D and S above) reflect the situation in which the firm produces the intermediate product internally. This graph reflects the value of the intermediate good in terms of exchanges made by market suppliers and demanders external to the firm. It does not express anything regarding the value of the internally produced intermediate good. As supply increases on the market, but not within the firm, the market value of the good decreases, all other things being equal. As demand for the intermediate good external to the firm increases it has the effect of increasing the value of a unit of the intermediate good, all other things being equal. In the second instance the

thinner supply and demand schedules (D' and S') would be the supply and demand schedules if the firm were to not produce the intermediate good, but purchase it off the open market after spinning off the intermediate good producing resources. In the example above, the market price of the intermediate good would increase from P to P' if the firm were to spin off the operation and purchase the intermediate good off the open market. This is still not an answer to the problem of what the intermediate good is valued at if produced internally. In addition, one would have to know both cases in making a still ill-informed decision. There is no way to know the value of internally produced intermediate products that are withheld from the open market. The market value of the good, during internal production is not necessarily the value of the good.

The answer for the value of such a good is based on judgment. The value of an intermediate good produced internally by a vertically integrated firm is a problematic object. We cannot observe such a value objectively. As the graph above depicts there would be a value for the intermediate good external to the firm but this valuation does not take into account the quantity of the good that the firm produces and its demand for such a good. In the event that the firm spins off the subsidiary that produces the intermediate good and then purchases the good from the open market a different price could arise on the market. Neither of these two pieces of information results in an observation that will allow the firm's owners and managers to determine the value of the internally produced intermediate good in a vertically integrated firm. The value of the good is not objectively known, and as such, any decision involving its value is based on judgment, rather than known a priori to the decision.

The true value of a factor of production, intermediate good in this case, is based on its usefulness in the eventual production of a consumer's goods. In a market economy, the use of money as a medium of exchange leads to there being a useful medium of account (money). Consumers' goods are thus valued in terms of the money units that it can command on the market. We cannot know the market price for the consumers' good prior to its production, but rather form a judgment regarding its future value after it is produced, transported, and marketed. Having this judgment, we can then relate the estimated future value of the consumer goods to the nearer cost of producing it. If the present value of the estimated sales price of the good is greater than the present value of the costs necessary to produce, transport and market the good and this difference is greater than the profit believed to be obtained by any other alternative, then production will be undertaken.

In large firms with many owners, or managers, scientific research and methods can be used to justify policies or projects to other owners and managers. With the existence of many decision-makers within the firm, each with their own interests and ideas regarding the future, scientific research and methods can be used to provide estimates of the profitability of various projects and polices. These projects and policies can be ranked, in accordance with their benefits, profitability being a major benefit and decisions made based upon the resources of the firm on which projects and policies to pursue and which ones to abandon. Estimates of future costs, revenues and profits can be estimated using scientific research and methods that may be viewed as objective, and valid. Firms in this case have an interest in paradigms that are believed to be able to produce these estimates.

In the case of a large vertically integrated firm, a problem with the valuation of intermediate goods produced and used within the firm exists. Since the intermediate goods are withheld from the market, they have no prices and as such, their value is unknown, in the form of a money price. Since profits and losses are calculated in terms of money, calculation of the profitability of internal production of intermediate goods is problematic. Scientific research and methods that produce usable estimates of the value of these non-market goods is of use to managers and owners in persuading others that such processes are profitable, or preferable to outsourcing the production of these goods or purchasing them from market suppliers. Paradigms that produce such usable estimates are preferred to other paradigms that do not produce such estimates, all things being equal.

Firms must make decisions in a world in which the success of their actions are dependent upon the actions of others, and the presence of conditions that are outside of their control. They must also relate these conditions and actions to the choice of an action that maximizes benefits in this environment. These factors include theories and research relating to macroeconomic phenomena such as economic growth, monetary issues and business cycles. A paradigm that can provide usable predictions of these events and the relationships between these events and the proper actions for the firm would be preferable to a firm.

It is important to note that the word truthful prediction was not used when describing these demands for science. Aside from the impossibility of such predictions in the sense that they accurately describe actions, these predictions do not have to be true,

only perceived as being useful in the achievement of some human need, directly or indirectly.

Consumers as Demanders of Science

Consumers demand scientific research and theories as well. Technology derived from this research can be applied to satisfying human needs that were previously not feasible, or to satisfy needs, already being satisfied, in a more efficient or expedient manner. A simple example of this would be good health. People in not wanting to be sick use scientific research to determine what to eat, what not to eat, medications to take to relieve illness, and ways of living their lives to minimize the chances they will become ill.

Paradigms supply the theories and research that are usable in developing technological ideas on the direct accomplishment of human needs. Where they are perceived to be capable of such things in a manner superior to all other paradigms, they receive funding through governmental, business and consumer sources. If they achieve results that do satisfy human needs, or produce results that are viewed as being optimal in relation to other potential or actual competitors.[11] Then this support will be continued until such time as they are no longer perceived to be capable of satisfying future human needs in a better manner. When this occurs, the seed is planted for the replacement of a paradigm through the process of scientific revolution.

As with any good, the satisfaction of a human need is a future oriented process. No one would buy a good to satisfy a past need, and immediately current needs are

[11] This optimality in relation to their competitors can also be optimal in efficiency. It may take 5 years under paradigm A to obtain an expedient result. While it may take 50 years to obtain a less expedient, but more lasting or truthful result under paradigm B. As such, time preference would play a role in paradigm choice, as well as the perceived benefits of the expedient versus the more truthful or lasting result.

unattainable as all actions take time. This is not being said to discredit other views regarding the assumptions of economics. These assumptions are made of necessity in producing predictions in an efficient and expedient matter. These assumptions in economics, or rather the lack of addressing time and the necessary time lapse between production and consumption are used in the prediction of certain variables, not as accurate descriptions of reality. It has previously been said that some writers believe science to be prediction. Prediction, in and of itself, is not science. If one predicted Caesar's death from reading entrails could this be called scientific? However, in describing problematic objects, such as the value of intermediate goods in a vertically integrated firm, or other non-market goods, such as public goods for a government, the objects are problematic. The predictions made are estimates formed ignoring certain complicating factors that are believed to be small. In this case, what is useful in prediction does not have to be true. However, this also follows to the point that the predictions are not true. They follow from certain metaphysical and methodological foundations that are based on judgment, not logic.

Supply Side of Science

Scientists, as we have pointed out earlier, do not practice their trade in isolation from human needs. The ivory tower is not self sufficient, those inside must rely on the consumer goods and services produced outside of the ivory tower. In doing so, they must produce goods and services themselves that are demanded by others engaged in the division of labor and specialization. As researchers and theoreticians they must provide research and theories that are initially perceived by demanders as being capable of being brought into causal connection with the satisfaction of human needs.

As suppliers of science, to obtain funding for themselves and their work, the bulk of it not directed too, nor funded by the scientific community itself, their product must be perceived as useful to demanders outside the scientific community. The supply of market goods obtainable to the scientist in the practice of science[12] is dependent on the perceived ability of his work to satisfy the human needs expressed above. If it is not perceived to be capable of accomplishing the satisfaction of the human needs expressed above then he will not receive funding for the research or the sustaining of himself or lifestyle during the accomplishment of the research chosen. In this instance, unless the scientist, through his own means, has access to the resources needed to sustain himself, and his research, the research will not be undertaken.

The choice of a paradigm is of importance both personally and economically to the scientist. He expects certain psychic and economic goods from the performance of his research. In expecting these things, he is making predictions about the relative value of his research to demanders of scientific research and theories. The profitability of different paradigms and the theories and research that proceed from it are the criteria through which the scientist judges paradigms. Will the paradigm result in research and theories that can be brought into causal relations to the accomplishment of human needs? Does the prospective scientist have the ability to perform such research; will he enjoy it relative to some other form of employment, or in relation to research performed in a competing paradigm (should one exist)? Would the net benefits of developing a new paradigm be greater than those obtained by practicing normal scientific research within an already existent paradigm? What is the relative importance to the demanders of theories and research that follow from and can be accomplished by the acceptance of a paradigm?

[12] Complete or incomplete science.

What rewards can be expected from the practicing of a paradigm, both psychic (admiration, respect, and fame) and economic? These things are all answered through judgment. The scientist does not know that his research will go as expected, otherwise he would have to already know the answer and the research would be repetitive. He does not know that his research will be useful, or even perceived to be useful, as it still must be performed in order to for it to be useful, or perceived as useful. He must correctly anticipate future needs of his fellow human beings and their relative importance. The prospective researcher forms judgments about these things. These judgments of future demands and revenues are what the scientist acts on. Prospective scientists must wait to learn the paradigm's teachings, to perform scientific research and to develop theories. Only at some future point in time will they come to know if judgments have been accurate. It is possible that a prospective scientist could perform research that no one wants or cares about. Research and theories could be produced that no one will publish. The prospective scientist might not achieve the rewards that, expectations regarding the acceptance of a paradigm, or choice of problems, led to choosing the paradigm in the first place. The possibility of error is present in the choices a perspective scientist makes regarding paradigm acceptance and the choice of subject matter in which theories and research is directed.

In incomplete sciences with problematic objects as their subject matter, the assumptions regarding methodological and metaphysical foundations may also be in error. These assumptions, in this case, are accepted based on judgment not logic or philosophy. Logic and philosophy are not capable of determining the answers to this question at the point in time these paradigms are needed to solve human wants. If

metaphysics and logic could provide the answers as to the foundations of these paradigms, then instead of being incomplete science these paradigms would have synthetic a priori premises rather than arbitrary assumptions chosen in the interest of expediency and their perceived usefulness is satisfying future human needs.

New Entrants to a Field and Practitioners of the Old Paradigm

Why is it that new paradigms are more acceptable to new entrants rather than practitioners of the old paradigm? The answer lies in the expectations of net benefits over the scientists working life of accepting a new paradigm. All other things being equal, a scientist with a greater length of serviceable use for a paradigm will benefit more from a correct choice than will an older scientist with a shorter serviceable use of a paradigm. The acceptance of a paradigm is a choice that will have ramification to the expected benefits a scientist expects to receive over the course of his career. In the example below assume that over the course of time that A_n is the net benefit receivable in year n for the old paradigm. Also, assume that the net benefit to practicing within an alternative paradigm is B_n in year n. It would take a scientist of equal talent 5 years to adequately learn the new paradigm. In this case, the present value of a scientist who expects to practice either paradigm for 20 years would look like the following. We assume that in all cases $B_n > A_n$ for all n= 1 to 25years.

The present value of choosing paradigm B is equal to (PV_B)

The present value of choosing paradigm A is equal to (PV_A)

The cost of learning the paradigm (Co_n). Co_n is assumed to be negative (a cost) and constant and equal for both scientists and new entrants over all years.

X_n is the opportunity cost of entering the field.

For the new entrant:

$$PV_B = (Co_1 + X_1)/(1+r)^1 + (Co_2 + X_2)/(1+r)^2 + (Co_3 + X_3)/(1+r)^3 + (Co_4 + X_4)/(1+r)^4 + (Co_5 + X_5)/(1+r)^5 + (((B_6 - X_6)/(1+r)^6) + ((B_7 - X_7)/(1+r)^7) + (B_8 - X_8)/(1+r)^8) + (B_9 - X_9)/(1+r)^9) + (B_{10} - X_{10})/(1+r)^{10}) + (B_{11} - X_{11})/(1+r)^{11}) + (B_{12} - X_{12})/(1+r)^{12}) + (B_{13} - X_{13})/(1+r)^{13}) + (B_{14} - X_{14})/(1+r)^{14}) + (B_{15} - X_{15})/(1+r)^{15}) + (B_{16} - X_{16})/(1+r)^{16}) + (B_{17} - X_{17})/(1+r)^{17}) + (B_{18} - X_{18})/(1+r)^{18}) + (B_{19} - X_{19})/(1+r)^{19}) + (B_{20} - X_{20})/(1+r)^{20}) + (B_{21} - X_{21})/(1+r)^{21}) + (B_{22} - X_{22})/(1+r)^{22}) + (B_{23} - X_{23})/(1+r)^{23}) + (B_{24} - X_{24})/(1+r)^{24}) + (B_{25} - X_{25})/(1+r)^{25})$$

We can say that $C= (Co_1 + X_1)/(1+r)^1 + (Co_2 + X_2)/(1+r)^2 + (Co_3 + X_3)/(1+r)^3 + (Co_4 + X_4)/(1+r)^4 + (Co_5 + X_5)/(1+r)^5$. These are the present value of the costs necessary to acquiring the paradigm for a new entrant to the degree that work within it can be undertaken. This cost can be considered to include lost wages from the next best available option available and the opportunity costs of resources used to fund the educational process.

We can say that $\mathbf{PB_{20} = (B_6 - X_6)/ (1 +r)^6) + ((B_7 - X_7)/ (1 +r)^7) + (B_8 - X_8)/ (1 +r)^8) + (B_9 - X_9)/ (1 +r)^9) + (B_{10} - X_{10})/ (1 +r)^{10}) + (B_{11} - X_{11})/ (1 +r)^{11}) + (B_{12} - X_{12})/ (1 +r)^{12}) + (B_{13} - X_{13})/ (1 +r)^{13}) + (B_{14} - X_{14})/ (1 +r)^{14}) + (B_{15} - X_{15})/ (1 +r)^{15}) + (B_{16} - X_{16})/ (1 +r)^{16}) + (B_{17} - X_{17})/ (1 +r)^{17}) + (B_{18} - X_{18})/ (1 +r)^{18}) + (B_{19} - X_{19})/ (1 +r)^{19}) + (B_{20} - X_{20})/ (1 +r)^{20}) + (B_{21} - X_{21})/ (1 +r)^{21}) + (B_{22} - X_{22})/ (1 +r)^{22}) + (B_{23} - X_{23})/ (1 +r)^{23}) + (B_{24} - X_{24})/ (1 +r)^{24}) + (B_{25} - X_{25})/ (1 +r)^{25}).}$ These are the present value of net benefits received as a direct result of accepting and working within the new paradigm for the entrant to a field.

For a new entrant entering the field under the old paradigm, the costs will be considered the same, the present value of which will still be **C**. the present value of the net benefits to acquiring and practicing the old paradigm (PA) will be;

$$\mathbf{PA_{20} = (A_6 - X_6)/ (1 +r)^6) + (A_7 - X_7)/ (1 +r)^7) + (A_8 - X_8)/ (1 +r)^8) + (A_9 - X_9)/ (1 +r)^9) + (A_{10} - X_{10})/ (1 +r)^{10}) + (A_{11} - X_{11})/ (1 +r)^{11}) + (A_{12} - X_{12})/ (1 +r)^{12}) + (A_{13} - X_{13})/ (1 +r)^{13}) + (A_{14} - X_{14})/ (1 +r)^{14}) + (A_{15} - X_{15})/ (1 +r)^{15}) + (A_{16} - X_{16})/ (1 +r)^{16}) + (A_{17} - X_{17})/ (1 +r)^{17}) + (A_{18} - X_{18})/ (1 +r)^{18}) + (A_{19} - X_{19})/ (1 +r)^{19}) + (A_{20} - X_{20})/ (1 +r)^{20}) + (A_{21} - X_{21})/ (1 +r)^{21}) + (A_{22} - X_{22})/ (1 +r)^{22}) + (A_{23} - X_{23})/ (1 +r)^{23}) + (A_{24} - X_{24})/ (1 +r)^{24}) + (A_{25} - X_{25})/ (1 +r)^{25}}$$

Since the acceptance of a paradigm is based on the perceived costs and benefits, we will look at the expected values. Thus:

$$\mathbf{E[PB_{20}] = E[(B_6 - X_6)/ (1 +r)^6) + ((B_7 - X_7)/ (1 +r)^7) + (B_8 - X_8)/ (1 +r)^8) + (B_9 - X_9)/ (1 +r)^9) + (B_{10} - X_{10})/ (1 +r)^{10}) + (B_{11} - X_{11})/ (1 +r)^{11}) + (B_{12} - X_{12})/ (1 +r)^{12}) + (B_{13} - X_{13})/ (1 +r)^{13}) + (B_{14} - X_{14})/ (1 +r)^{14}) + (B_{15} - X_{15})/ (1 +r)^{15}) + (B_{16} - X_{16})/ (1 +r)^{16}) + (B_{17} - X_{17})/ (1 +r)^{17}) + (B_{18} - X_{18})/ (1 +r)^{18}) + (B_{19} - X_{19})/ (1 +r)^{19}) + (B_{20} - X_{20})/ (1 +r)^{20}) + (B_{21} - X_{21})/ (1 +r)^{21}) + (B_{22} - X_{22})/ (1 +r)^{22}) + (B_{23} - X_{23})/ (1 +r)^{23}) + (B_{24} - X_{24})/ (1 +r)^{24}) + (B_{25} - X_{25})/ (1 +r)^{25});]}$$

$$\mathbf{E[PA_{20}] = E[(A_6 - X_6)/ (1 +r)^6) + (A_7 - X_7)/ (1 +r)^7) + (A_8 - X_8)/ (1 +r)^8) + (A_9 - X_9)/ (1 +r)^9) + (A_{10} - X_{10})/ (1 +r)^{10}) + (A_{11} - X_{11})/ (1 +r)^{11}) + (A_{12} - X_{12})/ (1 +r)^{12}) + (A_{13} - X_{13})/ (1 +r)^{13}) + (A_{14} - X_{14})/ (1 +r)^{14}) + (A_{15} - X_{15})/ (1 +r)^{15}) + (A_{16} - X_{16})/ (1 +r)^{16}) + (A_{17} - X_{17})/ (1 +r)^{17}) + (A_{18} - X_{18})/ (1 +r)^{18}) + (A_{19} - X_{19})/ (1 +r)^{19}) + (A_{20} - X_{20})/ (1}$$

$+r)^{20}) + (A_{21} - X_{21})/ (1 +r)^{21}) + (A_{22} - X_{22})/ (1 +r)^{22}) + (A_{23} - X_{23})/ (1 +r)^{23}) + (A_{24} - X_{24})/ (1 +r)^{24}) + (A_{25} - X_{25})/ (1 +r)^{25}]$

Therefore, if $E[PB_{20}] - C > E[PA_{20}] - C$ the new entrant will choose paradigm **B** (the new paradigm) if the Expected net benefits to B over the 20 years of expected usefulness are in excess of the expected net benefits to accepting and practicing the old paradigm (**A**). The equation above can be changed by adding C to both sides to say; If **$E[B_{20}] > E[A_{20}]$** then the new entrant will accept the new paradigm **(B).**

Below is a table of potential expected monetary values for undertaking a field in which there is two competing paradigms. The older **paradigm A** is the dominant paradigm in the field at the time a decision must be made regarding the acceptance of a paradigm. **Paradigm B** is a newer competitor in the same field. We will use monetary values only, assuming for simplicities sake that all other factors involved in paradigm choice are equal to the entrants, or insignificant in their relation to monetary values for the given field in making their choice of a paradigm within the field. We will also assume that the opportunity costs outside of the field are all equal or negligible for simplicity sake.

In the first table, new entrants into paradigm A can expect fast growth in their earnings during the eight years of their practicing the new paradigm and a gradual decline in potential earnings during the remaining 12 years of their practice. During the last 5 years of practice they can actually expect to lose their dominance within the field and their earnings are less than they would have otherwise been had the undertaken work in the competing paradigm (B).

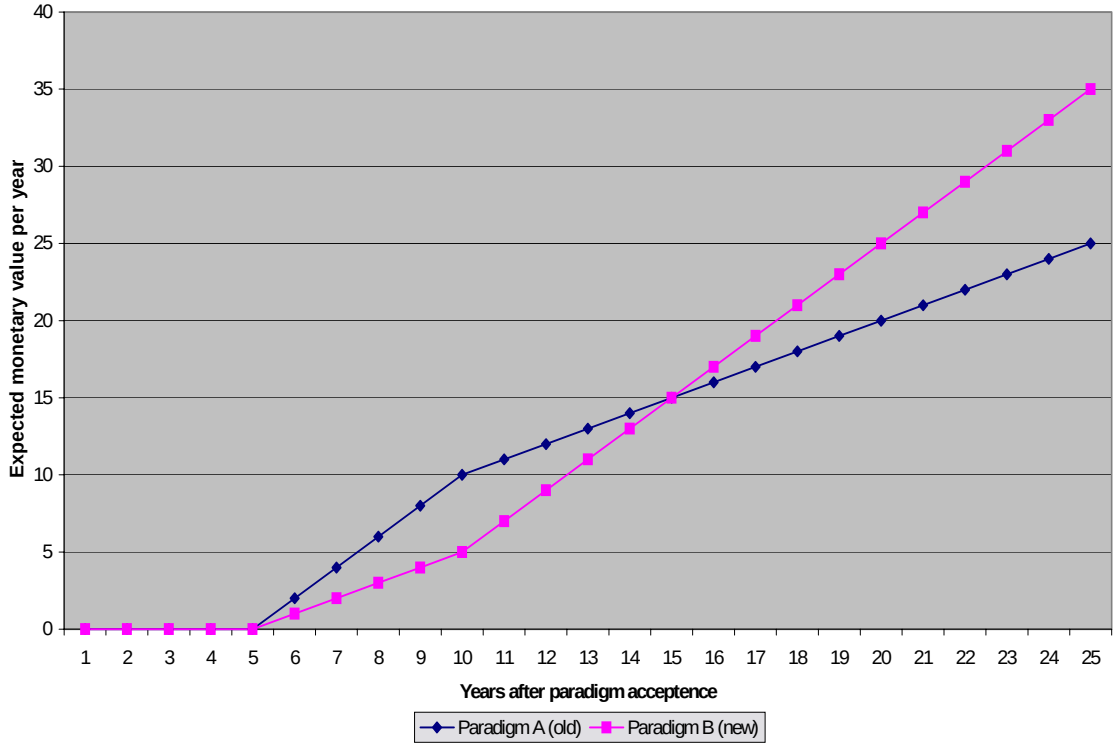
Table 4-1.

Absolute Yearly Benefits to Undertaking Work in a Paradigm

	Benefits					
Time	Old A1	New B1	Old A2	New B2	Old A3	New B3
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	2	1	5	1	5	0
7	4	2	10	2	10	0
8	6	3	15	3	15	0
9	8	4	20	4	20	0
10	10	5	25	5	25	0
11	11	7	30	6	26	2
12	12	9	35	7	27	4
13	13	11	35	10	28	6
14	14	13	29	15	29	8
15	15	15	30	20	30	10
16	16	17	29	25	30	15
17	17	19	28	30	30	20
18	18	21	27	40	30	25
19	19	23	26	45	30	30
20	20	25	25	45	30	35
21	21	27	24	45	15	40
22	22	29	23	45	8	45
23	23	31	22	45	6	50
24	24	33	21	45	4	55
25	25	35	20	45	2	60
sum	300	330	479	483	400	405

Below is a graph using the first set of values for Paradigm A and B; these values are titled Old A1 and New B1 on the table above.

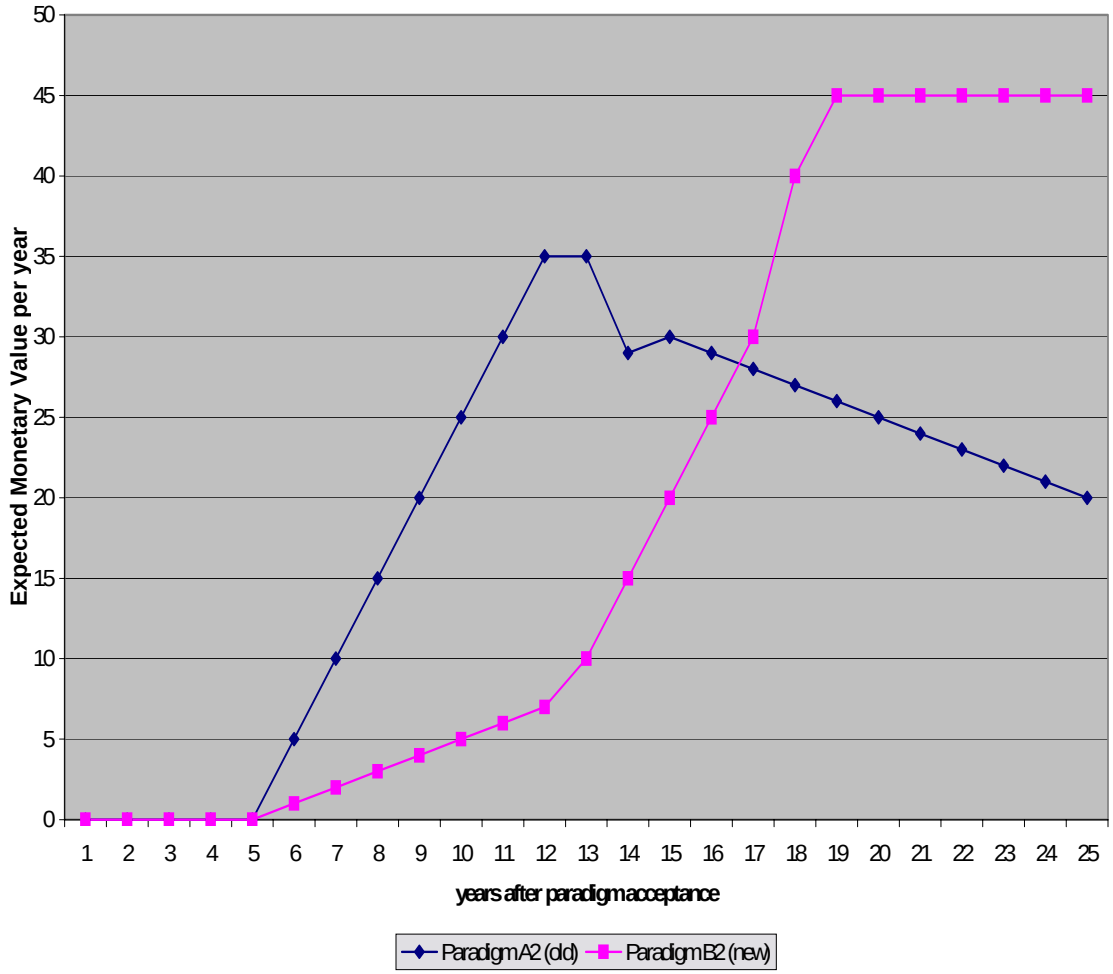
Graph 4-2. Expected Monetary Values for new entrants into a field with a dominant and a competing paradigm per year (Old A1 and New B1)



The graph on the previous page reflects assumed monetary benefits from two paradigms. Paradigm A is the dominant paradigm at the moment the student begins training and gradually falls out of favor to paradigm B.

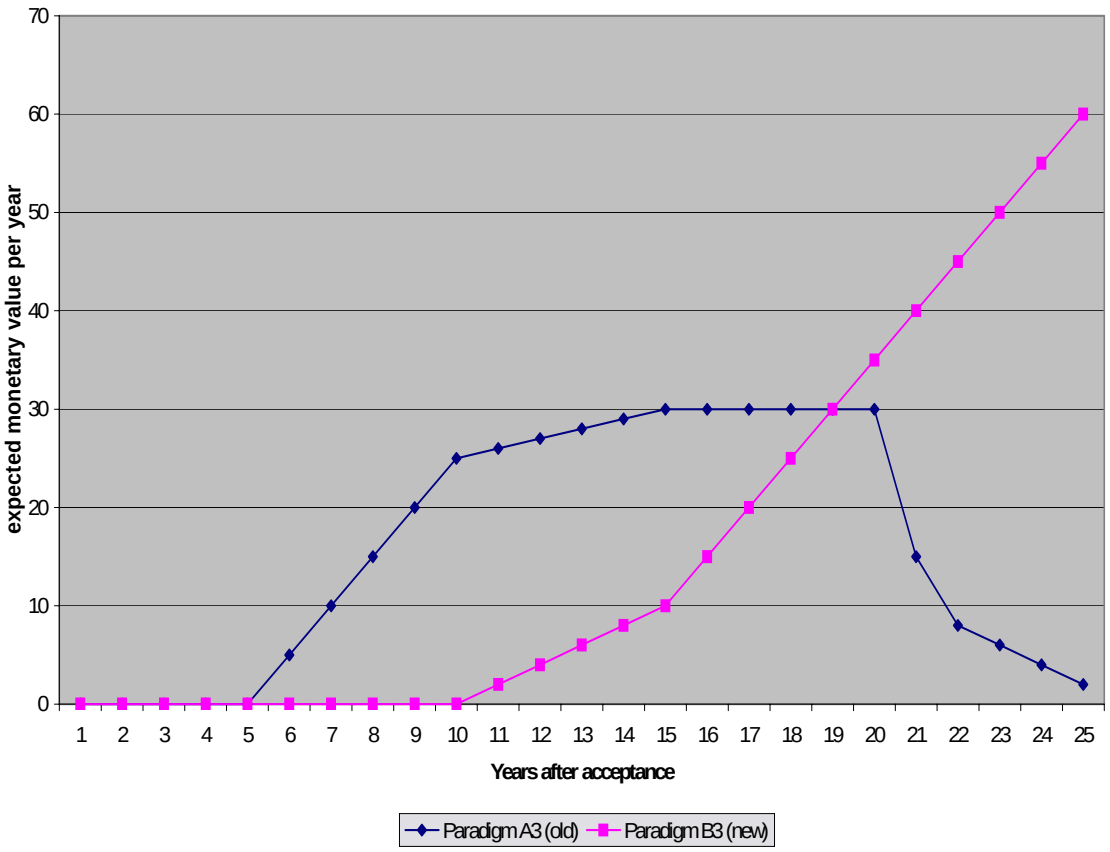
Below is a graph reflecting the values for a second scenario in which the new entrants to the dominant paradigm A expect to have increased earning power for the first 15 years and retain dominance within the field for 16 years. After which they will experience a gradual loss of earnings power and dominance over the remaining 9 years.

Graph 4-3. Expected Monetary Values for new entrants into a field with a dominant and a competing paradigm per year (Old A2 and New B2)



In the graph below, case 3 involves growth in the expected earnings of the new entrants into paradigm A3 for 15 years after which their earnings flatten out until the 21st year after which they plummet drastically. In this example paradigm A is the dominant paradigm for 19 years then quickly loses this dominance and quickly slides into oblivion relative to paradigm B3.

Graph 4-4. Expected Monetary Values for new entrants into a field with a dominant and a competing paradigm per year (Old A3 and New B3)



In each case above, the decision on which paradigm to accept would be based on the present values of the monetary gains, assuming all other things being equal, that each paradigm would be expected to produce over 25 years. Thus, the present values for each paradigm under each case are presented using a 10% personal interest rate.

Case 1: assuming a personal interest rate of .1
Present value of paradigm A: $E(PA_{20}) - C = 60.96637$
Present value of Paradigm B: $E(PB_{20}) - C = 58.10239$

In this case the while the absolute value of earnings over the full 25 years are greater for new entrants into the newer paradigm (B), the increased earnings earlier in ones career generated by entering paradigm (A) outweigh increased later earnings in paradigm (B).

Case 2: assuming a personal interest rate of .1
Present value of paradigm A: $E(PA_{20}) - C = 114.0511$
Present value of Paradigm B: $E(PB_{20}) - C = 79.99145$

In this case the while the absolute value of earnings over the full 25 years are greater for new entrants into the newer paradigm (B), the increased earnings earlier in ones career generated by entering paradigm (A) outweigh increased later earnings in paradigm (B).

Case 3: assuming a personal interest rate of .1
Present value of paradigm A: $E(PA_{20}) - C = 114.0511$
Present value of Paradigm B: $E(PB_{20}) - C = 79.99145$

In this case the while the absolute value of earnings over the full 25 years are greater for new entrants into the newer paradigm (B), the increased earnings earlier in ones career generated by entering paradigm (A) outweigh increased later earnings in paradigm (B).

In the examples above, entrants into the field will not choose the new paradigm. With personal interest rates of 10% per year, the increased near term earnings of paradigm (A) outweigh the future increased earnings of the new paradigm (B). However,

if we decrease the personal interest rates of the new entrants to 5%, we see that under the same expectations scientific revolution becomes more likely as the future increased earnings of the new paradigm become more highly valued. Thus, all other things being equal, we can see that a lower time preference among entrants to a field tends to quicken the pace of scientific revolution. It could also be determined that among new entrants to a field, that individuals with lower time preferences are more likely to practice revolutionary paradigms, all other things being equal and assuming that future rewards to practicing a new paradigm are expected to be higher in the long run.

Case 1: assuming a personal interest rate of .05
Present value of paradigm A: E (PA_{20}) - C = 128.6399
Present value of Paradigm B: E (PB_{20}) - C = 132.1583

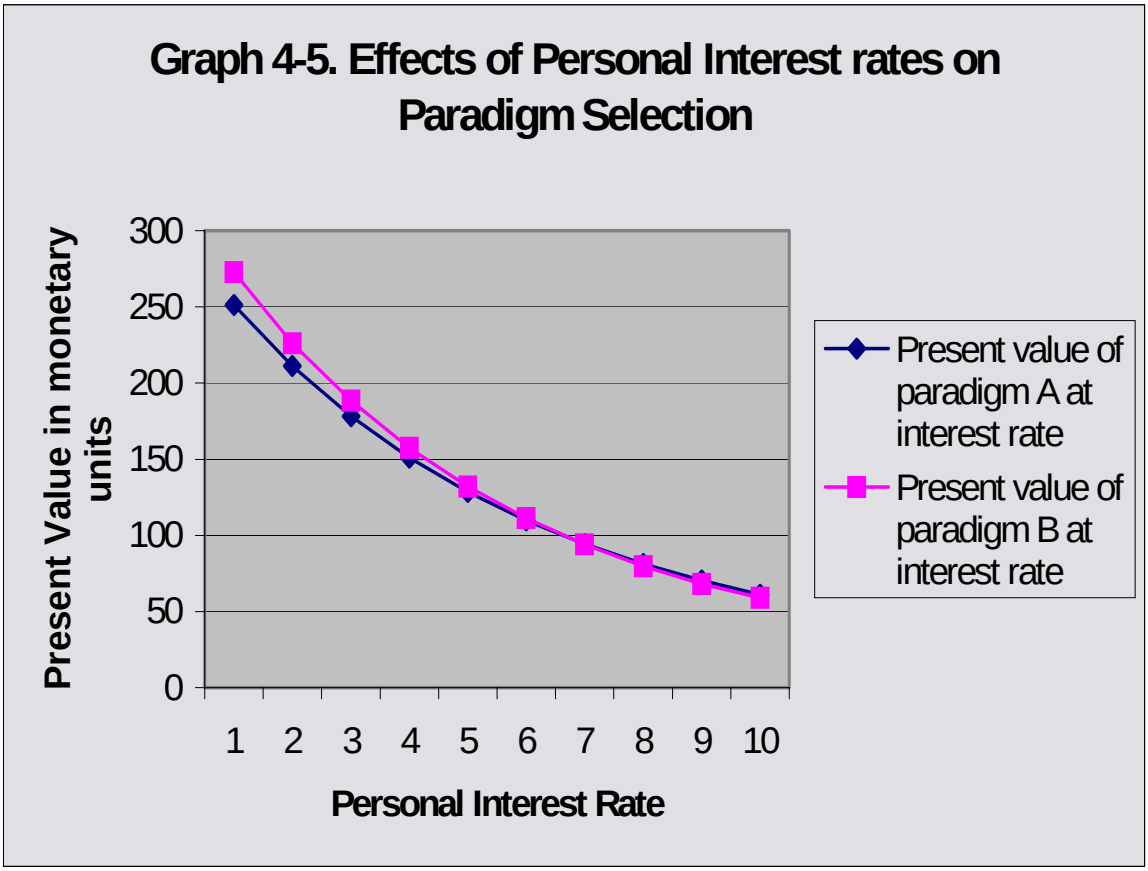
In this case the absolute value of earnings over the full 25 years are greater for new entrants into the newer paradigm (B), the increased earnings earlier in ones career generated by entering paradigm (A) no longer outweigh increased later earnings in paradigm (B).

Below is a table with present values for practicing paradigm (A) the dominant paradigm and paradigm B the newer paradigm that will become dominant from case 1 above. In this case, the interest rate will vary from 1% to 10 %. At interest rates less than 7% the new entrants will choose the newer paradigm. In this case, the future increased earnings potential of practicing the newer paradigm (B) are not outweighed by the increased nearer term earnings of Paradigm (A). With personal interest rates greater than 7%, the increased future earnings of Paradigm (B) are outweighed by the greater nearer term earnings potential of paradigm (A). Thus, we can see that the personal interest rates

of new entrants to a field can have an effect on scientific revolution. Higher rates all other things being equal can delay scientific revolution in the short term.

Table 4-2. The Effect of Personal Interest Rates on Scientific Revolution

Interest Rate	PV E(A_{20})	PV E(B_{20})
0.01	251.1263	**272.6896**
0.02	211.1217	**226.2215**
0.03	178.2438	**188.3894**
0.04	151.1146	**157.4903**
0.05	128.6399	**132.1583**
0.06	109.9479	**111.3161**
0.07	**94.34163**	94.10719
0.08	**81.26181**	79.84844
0.09	**70.25803**	67.99314
0.1	**60.96637**	59.10239



In the example above it can be seen that all other things being equal, the personal interest rates on new entrants into a field can have an effect on paradigm acceptance. In addition to the absolute expectations of new entrants as to the potential earnings (prior) to discounting, other factors may include prestige or other sociological factors as well as the ease or enjoyablity of various paradigms in relation to each other and alternative fields of study or employment. As stated earlier the possible earnings or alternative fields of study or work relative to the earnings within the field under consideration also have an effect of paradigm choice and entry into the field.

Established Practitioners and Scientific Revolution

The costs of an established practitioner say one who has practiced the old paradigm for 10 years and already spent 5 years acquiring the knowledge and tools necessary to practice the old paradigm will be $\mathbf{C_{10}}$. These costs will include the cost of education and the lost value of practicing the old paradigm. $\mathbf{(C_n - (A_{25-n}/(1+r)^n)}$ for all n = 1 to 10 (The range of n is 1-10 since 15 years of his 25 years of productive service has been spent in the old paradigm and is lost**).** We will assume here that any $\mathbf{E\ [A_{25-n} > X_n]}$ for all n. This would tend to make sense since the acquiring of a paradigm by any scientist must be more highly valued than his next best option, otherwise he could quit the science and undertake his preferred option. Thus for our established scientist his expected benefits to acquiring the new paradigm ($\mathbf{PB_{10}}$) is equal to;

The present value $PB_{10} = (C_1 - A_{15+1})/(1+r)^1) + (C_2 - A_{15+2})/(1+r)^2) + (C_3 - (A_{15+3})/(1+r)^3) + (C_4 - (A_{15+4})/(1+r)^4) + (C_5 - (A_{15+5})/(1+r)^5) + [(B_6 - A_{15+6})/(1+r)^6) +$

$(B_7 - A_{15+7})/(1+r)^7)\ (B_8 - A_{15+8})/(1+r)^8) + (B_9 - A_{15+9})/(1+r)^9) + (B_{10} - A_{15+10})/(1+r)^{10})$

The expected value of net benefits from accepting the new paradigm will be

$$\mathbf{E\ (PB_{10}) = E\ [(B_6 - A_{15+6}/\ (1+r)^6) + (B_7 - A_{15+7}/\ (1+r)^7)\ (B_8 - A_{15+8}/\ (1+r)^8) + (B_9 - A_{15+9}/\ (1+r)^9) + (B_{10} - A_{15+10}/\ (1+r)^{10})]}$$

The expected costs would be ($\mathbf{C_{10}}$)

$$\mathbf{E[C_{10}] = E[(C_1 - A_{15+1})/(1+r)^1) + (C_2 - A_{15+2})/(1+r)^2) + (C_3 - (A_{15+3})/(1+r)^3) + (C_4 - (A_{15+4})/(1+r)^4) + (C_5 - (A_{15+5})/(1+r)^5]}$$

Only if $\mathbf{E(PB_{10}) > E[C_{10}]}$ will the experienced practitioner with 5 years training and 10 years of practice under the old paradigm (A) switch to the new paradigm (B). We can solve for these values and conclude

For the practitioner with 10 years experience and 5 years of training in the old paradigm

$$\mathbf{[(B_6 - A_{15+6}/\ (1+r)^6) + (B_7 - A_{15+7}/\ (1+r)^7)\ (B_8 - A_{15+8}/\ (1+r)^8) + (B_9 - A_{15+9}/\ (1+r)^9) + (B_{10} - A_{15+10}/\ (1+r)^{10}) > [(C_1 - A_{15+1})/(1+r)^1) + (C_2 - A_{15+2})/(1+r)^2) + (C_3 - (A_{15+3})/(1+r)^3) + (C_4 - (A_{15+4})/(1+r)^4) + (C_5 - (A_{15+5})/(1+r)^5}$$

The following condition must be met for our experienced practitioner to switch paradigms.

$$\mathbf{\sum_{(n=\ 6\ to\ 10)}\ (B_n)/\ (1+r)^n > \sum_{(n=1\ to\ 5)}\ C_n + \sum_{(n=1\ to\ 10)}\ [A_{(10+n)}/\ (1+r)^n]}$$

In other words, the gains from 5 years of practicing the new paradigm must be greater than the cost of obtaining the education necessary plus the lost revenue for 10 years in the old paradigm as a senior practitioner. The increase in the costs of changing paradigms is extremely large and gets larger as one advances in a paradigm. The loss of

prestige and possibly benefits from previous research must be given up to change one's paradigm.

The work above is an example, but from it we can get a general view of what is entailed in switching paradigms for a senior practitioner of an older paradigm during scientific revolution. One gives up all the benefits of experience and in essence starts over. In addition, there are costs to acquiring a new paradigm and the serviceableness of the new paradigm is shorter. Thus, the benefits to accepting, at least outwardly, a new paradigm and practicing within it must be more than marginally larger than those expected under the older paradigm.

The benefits of seniority and experience can be lost during a paradigm change for an older practitioner and long time relationships with consumers of the older paradigm and colleague may be jeopardized as well. It seems no surprise that scientific revolution affects younger, entrants into the field. That older practitioners do not in great numbers adopt the newer paradigm is explainable under economic theory.

The Market for Ideas

The suppliers of science exchange their theories, and research through markets to individuals. These markets include both market and non-market institutions. They include research journals, universities and colleges, and conferences. The business firm may internalize scientific research in the interest of exclusivity, either by keeping scientific discoveries from others by not disseminating it, or through government-supplied patents and copyrights. Government demanders may also internalize scientific research. Some information is freely disseminated while other pieces of knowledge are kept secret, such as nuclear secrets and military technology. Regardless of the institution in which it is

exchanged, scientific theories and research are exchanged through market and non-market institutions.

For the following views regarding the value of scientific research, it is possible that the supply of other factors of production will alter the relationship of progress within a paradigm in certain instances. When we discuss the value of scientific research and theories, they are in relation to human needs. Human needs are not satisfied by knowledge alone. There are other factors necessary to the production of any good, physical or psychic. These goods must exist. Even the act of scientific research itself is dependent on other factors of production.

> . . . More important still, technological know-how can only have a material impact if it is utilized. Yet in order to do this, there must be savings and investment. It is not the availability of technical or scientific knowledge that imposes limits on a society's prosperity; rather, it is the amount of savings and investment that imposes limits on exploitation of actually available knowledge and on scientific progress, insofar as research activities, too, must be supported by saved up funds.[13]

When scientific research is viewed as being useful to demanders of science it becomes valuable. There are degrees of uncertainty during the commission of such research as to whether it will be accomplished successfully? Will someone else discover and monopolize the knowledge first? Will other discoveries needed to accomplish the goal towards which the research is directed be available in a time and at a cost that will make the goals toward which the research is directed feasible? These and other issues add to the uncertainty of scientific research in relation to human needs. For scientific research to be useful, the complimentary goods necessary to align it with human needs must also be in place. If not, if one complimentary item is missing, then the research is less useful

[13] Hans-Hermann Hoppe, *The Economics and Ethics of Private Property* (Boston: Kluwer Academic Publishers, 1993). P. 211-13.

than originally conceived and must be considered in error. It may have alternative uses, but those uses must, ex-ante, be less highly valued.

In the event that technology derived from the development of a theory is the only missing part, the theory becomes more urgent and consequently becomes more valuable. It is these problems that are especially attractive to developers of technology and the technology demanders impute this urgency to the scientists under whose competency such a theory falls. Fame and fortune are increased as the urgency of the theory increases. When scientific research is perceived to be possible and useful, then it has present value. This present value is decreased, all other things being equal, when as the degree of uncertainty regarding the eventual use of the knowledge in a technological combination with other factors of production to produce goods and services that will eventually lead to consumption, increases.

As has been laid out earlier, human needs, ranked in accordance with their importance, require consumer goods, leisure time to consume, land to consume them on, and technological knowledge to organize means in a way to accomplish these ends. The production of consumer goods, in an advanced economy, requires time, labor, land, entrepreneurship, capital goods and technological knowledge on how to combine the factors of production into consumer goods. To produce capital goods requires these same inputs directed towards the construction of consumer goods. In all of these instances, scientific knowledge can be useful in developing technological ideas necessary to the satisfaction of human ends. In addition, education can also be a consumer or a producer's good. I demand to know simply to know, or I demand to know so that this knowledge can be used in the formation of technological ideas related directly or indirectly to the

satisfaction of human needs, my own or others. Scientific research and theories are useful in forming true relationships between things in the mind-independent world and mind – dependent world. Human needs are mind-dependent; consumer goods and other factors necessary to consumption are not. Technological knowledge is the link between the mind-dependent human needs and the mind-independent consumer goods and other factors necessary to satisfy those needs.

The Reconstruction of Kuhn

Man lives in a world of scarcity. There are virtually unlimited human wants and only a limited supply of things; we can call these things economic goods, available to satisfy human needs. As such, we live in a world of uneasiness. The relieving of uneasiness is accomplished through the achievement of goals. These human goals are ranked in accordance with their importance to us. One of the limitations to the accomplishment of goals is the scarcity we experience in both time and physical bodies. We cannot simultaneously accomplish all our perceived needs at the same time. Even if we lived in a world were everything else were present in superabundance.

In living in a world of scarcity, there are always human needs that must, and do, go unmet. Thus, we must economize on our choices of goals to pursue at any one time. We rank our goals in accordance with their importance and choose the highest ranked goals to accomplish and leave lower ranked goals unaccomplished. This is the law of diminishing marginal utility.

In acting one chooses amongst various possible options, we call these goals. An example would be if I had one hour of leisure time available. I could, based on subjective preferences and the control over quantities of complimentary items, choose among the following options.

1) Read a book for enjoyment for one hour.
2) Watch the news, for enjoyment and to gain knowledge about the world around me for one hour.
3) Take a nap for one hour.

If I rank these options in the order above, then I prefer reading to watching the news and I prefer watching the news to sleeping. With one hour of leisure time, I will allocate that hour to the highest ranked possible goal. Provided I have a book a nice comfortable chair and an hour of time, making goal 1) possible. I will allocate my time to reading. By doing so I give up my next best achievable alternative, watching the news, provided I have all the necessary goods required to do so. By choosing to read a book, I give up watching the news. Ex-ante, I believe that by reading the book I will relieve the greatest degree of uneasiness in my life possible at that point in time.

Is it always the case that my judgment regarding the use of scarce resources is always correct? The answer is no, by our very nature human beings make mistakes. It could be that some interesting development has occurred on the news, something, had I anticipated it, would be preferred to reading the book. It could also turn out that the book I choose to read was horrible. After the fact, ex-ante, I would realize I had made an error in choosing the book over the news, and if there were still time left when I realized this, switch to watching the news. I would have suffered a loss in this instance. I could have

done better. By making a choice, I have made a prediction about the future, one that is not based entirely in fact, but rather based on judgment. This is an entrepreneurial act, as all actions must be.

Science is an action. Science being the discovery of things, their natures and the relationships between things, is by definition and its very nature a human action and falls under the umbrella of praxeology. The determinations of what questions to answer, and what methods and paradigms to use in attempting to discover an answer are all entrepreneurial actions. They deal with uncertainty, both the uncertainty under investigation and the uncertainty of success in the investigation. If one knew the answer before hand then it must have already been known and thus a mere historical fact, or requiring an endless regress backwards of studies to find out if it is even possible to discover if it is possible to even be successful.

The motive force in scientific inquiry must be the satisfaction of some end. That end may be to change the physical world, or to change men's minds. Science is a tool that may be used to accomplish both of these tasks.[14] Action also is an attempt to do these things. Scientific activity must fall under the category of action.

Science as a Producers' Good.

The things that we find useful in the accomplishment of our goals are goods. These things if they are used to satisfy human needs directly are termed consumers' goods. If they are useful only indirectly in the satisfaction of human needs then they are called producers' goods. Producers' goods include the factors of production. These factors include, time, land, labor, capital goods (the produced factors of production),

[14] One could also use alchemy, witchcraft, superstition, or some non-scientific act to accomplish these tasks as well.

technology and entrepreneurship. Technology is a producer's goods. It is a plan to organize other factors of production in a way to produce some output. Land is all nature given resources, including the physical land, resources contained on and below the land, and any other feature of the land not produced as a result of human effort (such as the fertility of virgin soil, or game on the land). Labor is human effort directed towards the production of goods and services. Entrepreneurship is that aspect of action dealing with uncertainty. Finally, capital goods are the factors of production that must first be produced themselves. Human capital is often also used as a factor of production. It is self-improvement of labor; this increases what has been traditionally considered the skills of labor.

Scarce resources used in action are economic goods. To be a good the following conditions must apply according to Carl Menger.

1) A human need. - There must exist some human need. In living in a world of scarcity these needs are always present so long as there are men in it.

2) Such properties as render the thing capable of being brought into a causal connection with the satisfaction of the need. – There must be a cause and effect relationship possible between the thing and the satisfaction of this human need from number 1 above.

3) Human knowledge of this causal connection. - Man cannot act unless he has knowledge of the causal connection listed in number 2) above.

4) Command of the thing sufficient to direct it to the satisfaction of the need. – One cannot act unless he has control over the thing that fits conditions 1) through 3) above.[15]

Menger goes on to state "Only when all four of these prerequisites are present simultaneously can a thing be considered a good. When even one of them is absent, a thing cannot acquire goods-character, and a thing already possessing goods-character would lose it at once if but one of the four perquisites ceased to be present."[16]

For each action, the following preconditions must be met.

1) There must be uneasiness. The need is the relieving of this uneasiness. Living in a world of scarcity, it will never be the case that man has attained satiation. There will always be goals for which the means necessary to satisfy will not exist.
2) The individual must have a plan to alleviate the uneasiness
3) The scarce means necessary to relieve the uneasiness must be under his/her control.

Goods that exist in super abundance at the time of action are free goods and are not factors in human choice. They become general conditions of action. An example is air in the room that I am writing. There is, and I believe it, more air available in this room that I could ever use. Thus when I take a breath, I do not worry about the inability of anyone to use air in the room for the foreseeable future. We do not economize free goods and they are thus not considered in human choice since we do not have to choose between various uses for them.

[15] Carl Menger, *Principles of Economics* (Grove City Pa.: Libertarian Press, Inc., 1994). P. 52.
[16] Ibid., p. 52

Economic goods are goods that are scarce. Scarcity exists when there are more human needs requiring a thing than there are things available to satisfy those needs. My time is scarce. By writing this paper, I give up alternative uses of my time such as being home with my family.

Scientific research is a good. It is a producers' good from our definitions above, unless done for its own sake. Scientific research, if it is useful, must be directed towards the satisfaction of some human need. In the event that it is not viewed as being useful then it can lose this distinction. As it is carried out as an action, it must at the beginning be viewed as being potentially capable of satisfying some human need. It is no different than labor, except that it is direct end is not the satisfaction of some human end, or the direct production of a capital good. Its end is the production of new technologies. Technologies that will enable man to produce a good that did not previously exist, or to produce a good already known, produced in a more efficient, or more expedient manner or convince others to engage in some action they might not otherwise have undertaken.

It differs from goods that are extended in time and space. These types of goods by nature of their extension are limited. Ideas, however, differ in that once something is known it is no longer scarce. Thus new ideas are scarce and once learned become free goods to the person in their possession, as long a person knows them and is permitted to use them in the absence of coercion.[17]

[17] Patent laws being a violation of this. If I know something, but someone else has discovered and patented it before I have, it is possible that the known idea is still scarce in that I cannot use it in its super abundance without having to pay at least to use it. While the knowledge is no longer scarce for me, its usefulness is as scarce. To know and to use knowledge are two different things in this case.

When acting, for each actor entering into action.

1) The achievement of utility, from his action will be perceived to exceed its psychic cost. Psychic costs are the forgone utility of the next best alternative that he could adopt with the available means. Both the psychic revenue and the psychic cost are purely subjective to the individual. Since all action deals with units of supply of a good, we may refer to these subjective estimates as marginal utility and marginal cost, the marginal signifying action in steps. Where this perception is wrong, me make mistakes of errors.

2) Each person acts in the present instant, on the basis of present value scales; to obtain *anticipated* end results in the future. Each person acts, therefore to arrive at a certain satisfactory state in the future. Each has a temporal horizon of future dates towards which his actions are directed. He uses present given means, according to his technological ideas, to attain his ends in the future. All actions take time, the word anticipated implies some degree of uncertainty, it is possible, and a fact of human nature, that *errors* can and will be made. As actions take time and are based on anticipated results, we must refer to ex-ante expectations and ex-post results. Where the two are one in the same action is successful. Where ex-post results differ from ex-ante expectations errors are made.

3) Every person prefers and will attempt to achieve the satisfaction of a given end in the present to the satisfaction of the end in the future. The fact of time preference, individuals prefer satisfaction of their goals sooner too later.

4) All goods are distributed by each individual in accordance with their utility to him. A stock of the units of a good is allocated first to its most highly valued uses, then to its next most highly valued uses and so on, the Law of Diminishing Marginal Utility.[18]

[18] *See*, Murray N. Rothbard, *Man Economy and State: A Treatise on Economic Principles* (Auburn, AL: Ludwig von Mises Institute, 1993). Especially chapter one on "Fundamentals of Human Action."

Principles 1 and 2 listed above indicate that actions are undertaken in the present in order to accomplish some future end. Thus, the results of our actions are unknown to us at the time of their undertaking. It would be impossible to know with absolute certainty the result of any action, since to know something it must be true. For an event to be a true event, it must have taken place and exist as an historical fact. Our actions take time, thus when we undertake them we must wait for the anticipated results. In all actions, some degree of uncertainty is present in the relationship between the organization of the means and the end result.

Since our actions are all future oriented, there is a degree of uncertainty associated with all of them. As such, we must rely on judgment rather than scientific fact in undertaking them. This is as true of a simple action such as taking a drink of water to quench a thirst as it is of complex production processes, or undertaking scientific research. No action would take place in which an actor did not perceive his action as being accomplished, however, he cannot know with absolute certainty that his means will accomplish his goal, or that conditions not under his control will change or differ from his expectations.

Producers' goods are the factors of production useful in the eventual production of some consumers' good. While it is possible that some scientists can and do formulate theories based on their own needs to know, most science, and education in general, is a producers' good. In these cases, science is a factor of production, useful towards the

eventual satisfaction of some human need. These needs are accomplished by science through its usefulness in the production of consumers' goods.[18]

The factors of production are, land (including nature given resources), labor, technology (plans on how to organize all factors of production into the production of some output), time, Entrepreneurship and capital goods (the produced factors of production). Technology is the factor of production that is derived from science. Technology is an idea, or plan, with which we organize scarce means to accomplish some goal. That goal may be the direct satisfaction of some need, such as quenching thirst, or the indirect satisfaction of some need, through its usefulness in the eventual production of a consumer good, which then can be used to directly satisfy some human need.

In forming prices for producers' goods, judgment is the tool of the entrepreneur. The entrepreneur is the person in society that deals with uncertainty. Where he is successful in forming and acting on good judgments about the future, he is rewarded by either psychic profit, or in business enterprise with economic profit. Where he is unsuccessful, he is penalized by psychic losses, or in business economic losses. Every individual regardless of his relationship to the factors of production operates in a world of uncertainty and thus must deal with that uncertainty, acting in an entrepreneurial capacity.

Scientists are no different. In undertaking scientific activity, the outcome of such activity is uncertain. If it were not, then the scientific action would be of no use and not undertaken, except as a form of entertainment. Thus, all scientists act in an

[18] This is due to the professionalization of the profession, as is documented later in the paper. If one is to make his living off of economic scientific activity, then he must assume that it has value to others. That it can be combined with other factors to satisfy the goals of others.

entrepreneurial manner when deciding what paradigm to use, what questions to answer and whether or not such activity will be successful, either psychically or monetarily.

This act of judgment in paradigm selection is no different from what Kuhn explains in his book. Kuhn refers to this act of judgment as faith. However, this act must not be confused with the faith that individuals may place in an omnipotent being. In the case of paradigm selection, the act of judgment comes with its own feed back mechanism. When judgment is in error, the result is a perceivable loss, either psychic, or economic. One can learn from this result and adjust accordingly. Through trial and error, one can know when he is in error, in that he did not receive what he had hoped for, or what he could have had in the event of a loss. Alternatively, his expectations were correct and he did receive what he had hoped for at the beginning of his action.

As an action, taking place through time, there are definite things we can say about scientific activity. One, that there must be uncertainty present. Two, it must be directed at the eventual future satisfaction of some human need. Three, this makes scientific activity an entrepreneurial action. As such, the laws of human action, economics in particular, apply. The future value scales of individuals in relation to the goals that they perceive can be accomplished using the new ideas, determine the value of such activity. The opportunity costs of producing the activity will the willingness of others capable of supplying it and thus its supply.

Education is also an activity oriented towards the accomplishment of future goals. Students assent to teachings based on the perceived relationship between various alternative paradigms and fields in relation to their own skills and abilities, and their prediction of the rewards related to various fields of endeavor and paradigms within those

fields. Since most graduate students in a field are acquiring knowledge to become professionals within that field, the relationship between their accepted paradigm and its occupational prospects are of a great concern. The dominant paradigm has as an advantage, in the recent employment histories of those who adhere to it.

In a free market, mistakes can be made in production techniques, product lines and input combinations. These mistakes cannot last for long on the market as the market rewards good decisions with profits and penalizes poor decisions with losses and eventual bankruptcy if wrong decisions are not corrected. The discipline of profit and loss applies only in free economic markets, but not in political or socialized markets.

When we discuss the nature of goods the question of whether or not a good meets the qualification of their' *actually* having "Such properties as render the thing capable of being brought into a causal connection with the satisfaction of the need?"[19] Menger discusses what happens when one expects that a good has such properties as render the thing capable of being brought into causal connection with the satisfaction of a human need, when in actuality it does not posses said properties.

> A Special situation can be observed whenever things that are incapable of being placed in any kind of causal connection with the satisfaction of human needs are nevertheless treated by men as goods. This occurs (1) when attributes, and therefore capacities, are erroneously ascribed to them, or (2) when non-existent human needs are mistakenly assumed to exist. In both cases we deal with things that do not, in reality, stand in relationship already described as determining the goods-character of things, but do so only in the opinions of people. Among things of the first class are cosmetics, all charms, the majority of medicines administered to sick by peoples of early civilizations and by primitives even today, diving rods, love potions, etc. For all these things are incapable of actually satisfying the needs they are supposed to serve. Among things of the second class are medicines for diseases that do not actually exist, the implements, statues, buildings, etc., used by pagan peoples for the worship of idols, instruments of torture, and the like. Such things, therefore, as derive their goods-character merely from properties they are imagined to posses or from needs merely imagined by men may appropriately be called imaginary goods.
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> As a people attains higher levels of civilization, and as men penetrate more deeply into the true constitution of things and of their own nature, the number of true goods becomes constantly larger, and as can easily be understood, the number of

[19] Menger, p. 53

> imaginary goods becomes progressively smaller. In is not unimportant evidence of the connection between accurate knowledge and human welfare that the number of so-called imaginary goods is shown by experience to be usually greatest among peoples who are poorest in true goods.[20]

Menger makes a point that these imaginary goods are gradually eliminated over time as an economy prospers. In doing so, he attributes the decline of the quantity of imaginary goods to the achievement of higher levels of civilization. What is civilization and due to what causes does it reach higher levels. We can look to the market in such a case. The division of labor, through the growth of markets can lead to an increase in the well-being of individuals. The existence of imaginary goods is due to the presence of uncertainty and thus its consequence human error. The free and unhampered market tends to correct for error through profit and loss. Thus, we would tend to see improvements in the quantity of true goods in a free market and the reduction of imaginary goods.

Profit and loss is a feedback mechanism to prior decisions. In the case where a decision was correct, profits are made. They can be psychic profits in acts of consumption. I am better off having read a book rather than watching the news. In this case, using the example from earlier in this chapter, I choose reading a book over my next best option of watching the news, as a result I found myself to be better off. On the other hand, errors can also be made. For example, I would have been better off watching the news because a war broke out and I did not anticipate this. As a result, I read the book when I would have been better off watching the news. If I had correctly anticipated the war coverage, I would not have read the book, but watched the news. Here due to poor foresight I choose an inferior option 'reading the book,' at the expense of a preferred option, ex-ante, of watching the war coverage on the news.' In this case, I suffered a psychic loss. I could have been better off than I am.

[20] Menger, p. 53-54.

In market activities, those in which individuals freely homestead, produce and exchange goods and services on unhindered markets, the same applies. In these cases, however, economic profits and losses are the norm. In this case, we can calculate the profit and loss in a monetary economy. A project, all other things being equal, that produces a greater monetary profit, is preferred to any other. In this case, entrepreneurs forecast future demands and act in the present to undertake the satisfactions of these demands through the production of goods and services. These goods may be producers' goods, in which case the time frame between production and consumption is longer for these goods than it is for consumers' goods. Consumers' goods are those most closely related to consumption in terms of time. In each case, the successfulness of each actor's judgment is feed back to him in the form of economic profits, or losses. If one continues to fail, through poor judgment, his supply of the factors of production will continue to dwindle until he is in a position of not controlling them at all. In this case, the entrepreneur becomes a member of the labor pool.

Scientists on the other hand produce paradigms, theories and research that are directed towards some future human need. That need may be internal or external to the scientist or the community of scientists. In the first case, that need may be personal. In the second, scientific paradigm formation, theory formation, or scientific research is directed towards exchange.

The study of scientific activity, especially relating to the describing and explanation of the congeries of error, myth, and superstition that have inhibited the more rapid accumulation of the constituents of the modern science text,[21] requires one to understand what is in error. It also must explain why an error persisted or still persists today. There are at any time a number of human errors that are committed. This cannot be changed immediately. The actions, which are chosen in error, are based on fixed preferences and technologies. To change preferences or to correct technological errors would have had to have been done it the past. The market disciplines actors in this case, through losses, either psychic or monetary. One who does not accept these errors, or learn from them is doomed to repeat them to his own detriment. There are clear examples where this market discipline, rewarding good judgment and penalizing failed judgment, does not take place.

Regardless of one's views on government, independently we can show that governments, good or bad, do demand certain services, whether as true goods or imaginary goods, from mathematical economics. It is clear that in the presence of government interventions, whether they are price controls, quotas on imports, regulations on productive activity, taxation, or social welfare spending, that some justification is needed. In addition, these policies must be managed in a way that accomplishes the goals of the bureaucrats and politicians, who support and fund them, in a manner they find acceptable.

[21] Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. 1-2.

On free and unhampered markets ex-ante judgments regarding the profitability of projects and ex-post results are what determine when and if projects should be commenced and whether or not they should continue. Entrepreneurs form judgments about the future revenues that may be earned through productive activity, discount them and compare them to present costs. They do this, conceiving of believably possible projects and then allocate their time and capital towards those projects that they deem to be the most profitable. Higher profit making projects are funded first and projects anticipated to make losses are never funded.

The market disciplines their judgments. Where entrepreneurs have made better judgments than their fellows and satisfied future consumer needs, they make profits. Where their judgments fail to correspond to future consumer needs they suffer losses. The presence of a loss does not indicate a complete failure; however, continued losses remove poor entrepreneurs of their capital and savings, driving them from the market as entrepreneurs.

In making an error, entrepreneurs take resources that could have been used to satisfy a different set of future goals and allocate them towards one project. If this project resulted in the use of resources that could have been better used to satisfy future human needs in some other way their actions result in economic losses. These losses can be monetary, or accounting losses, or economic losses in that they could have done better but did not with those resources using them in some other project.

During the commission of an error, where ex-ante judgment is realized to be wrong, projects are disbanded and the resources reallocated either through redirecting

their use or liquidation. In this way the market gives entrepreneurs feedback on their decisions.

Governments are not disciplined by profit and loss. They are outside the boundaries of the free market.

> The market economy is the social system of the division of labor under private ownership of the means of production. Everybody acts on his own behalf; but everybody's actions aim at the satisfaction of other people's needs as well as at the satisfaction of his own. Everybody in acting serves his fellow citizens. Everybody, on the other hand, is served by his fellow citizens. Everybody is both a means and an end in himself; an ultimate end for himself and a means to other people in their endeavors to attain their own ends.
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> The system is steered by the market. The market directs the individual's activities into those channels in which he best serves the wants of his fellow men, There is in the operation of the market no compulsion and coercion. The state, the social apparatus of coercion and compulsion, does not interfere with the market and with the citizen's activities directed by the market. . .
>
> The market is not a place, a thing, or a collective entity. The market is a process, actuated by the interplay of the actions of various individuals cooperating under the division of labor.[22]

Economic calculation is the tool of the entrepreneur in a free market; the process of government interventions operates differently and in opposition to that of the market. Government interventions rely on coercion and compulsion to obtain resources, which are then allocated through a political process, not a market one. The government's policies are not disciplined through profit and loss. Revenues are not earned through voluntary exchanges, but rather through the state's power to tax. This power is dependent upon the consent of the governed. In the absence of economic calculation and the market discipline of profit and loss, bureaucrats have no way of knowing whether or not their policies and projects are errors.

[22] Ludwig von Mises, *Human Action, The Scholar's Edition* (Auburn, AL: Ludwig von Mises Institute, 1998). P. 258.

Here we see the problem that government officials need to solve. Resources are used efficiently in the absence of error. Since we are human beings and error is a necessary condition in which we all must live, uncertainty is the rule. As such, our actions can only be judged efficient after the fact, after one has followed an action through to its completion. Thus if ex-ante judgments match up to ex-post results, both in the relationship of the means to the chosen end and the relationships we presupposed in acting between different possible goals hold, then we can say that we acted in the best possible way. On the free market accounting profits do not mean that resources have been used efficiently, there could have been an alternative use for given resources that provided greater returns. Based on judgment about potential returns entrepreneurs will attempt to readjust their plans were required.

Governmental activity, absent the feedback of the market, must find alternative ways to justify and manage its projects. Evaluation of non-market goods in terms that can approximate the profit and loss feedback of the market is one demand placed upon economics. There is an absence of observable prices and opportunity costs implicit in a significant portion of the production of 'government goods.' A paradigm that is believed to be able to produce estimates of value for non-market goods, that replaces the price system of the free market, is of value to government bureaucrats, and policy makers.[23] A paradigm that maintains the impossibility of such valuations, or fails to provide valuations that are useful to the demanders of such services is at a disadvantage. As we will see later, funding for higher education is provided at the liberty of such demanders,

[23] The believability of a paradigm to produce these valuations can be on behalf of the rulers, the ruled or some significant proportion of both.

and when the majority of occupations within the field are in service to demanders of such evaluations.

Justifications for policies that involve the production of goods and services that do not involve market feedback are also useful to government policy makers and bureaucrats. Theoreticians who produce theories that justify governmental provision of certain goods and services are useful to the perpetuation bureaucracies and the gathering of public or internal support for new projects.[24] While it is clearly not true that all mathematical economists support the increase in the size and scope of all aspects of the state, it is clear that there are methods and theories within mathematical economics that are useful in justifying such action.

A paradigm that qualifies its predictions with a believable sense of objectivity is also useful to government policy makers and bureaucrats. The debate between positive and normative is relevant in using theories and research to justify policies at both the governmental and corporate level. In the presence of a large number of decision-makers or individuals with indirect or direct influence on the process, an objective arbiter is of necessity in settling disputes and gathering support. The veneer[25] of science attached to one's predictions and theories in of immense value to decision-makers. The putting aside of all biases and interests is a useful aspect of a prediction of justification. This in a sense is a quality of science. Thus if one can make others believe that his paradigm is capable of positive statements regarding how the world works, that is preferable to a paradigm in which doubt is cast on its' ability to do so. A paradigm that is viewed as more objective and less value laden is preferred to one that is not viewed as possessing those qualities.

[24] This is stated not to disparage government activities of government as a whole, but rather as a statement of fact. No one wants to hire an 'expert' who recommends the abolition of his position or the downsizing of his authority.
[25] Correct or incorrectly attached.

The same qualities that are expressed above are also useful to decision-makers in large corporate firms. Objectivity, the valuation of internally produced intermediate goods and services, as well as predictions regarding future business conditions and the actions of others relating to business conditions are useful to decision makers. These decision makers must convince owners, potential owners, managers, and employees that the actions of the firm will be value producing and produce profits, wages, and other benefits to the respective groups in excess of other alternatives. As such, corporate managers and owners demand some of the very same qualities in an economic paradigm that government decision-makers demand from it. A paradigm that can produce these services is preferred to others that cannot all other things being equal.

The Distinctions between, Acceptance, Usefulness, and Truthfulness.

> *All I have to say is this: being true is different from being taken to be true, whether by one or many or everybody, and in no case is to be reduced to it. There is no contradiction in something's being true which everybody takes to be false.*[26]

As we have explained earlier, the act of acceptance is based on judgment. That what is accepted must be true is in error. We accept things based on their perceived usefulness. Only in acting on accepted ideas can we discover whether or not they are truly useful. To be useful, in at least some circumstances, does not mean that or ideas must be truthful. To always be useful, in every possible instance, would necessitate that what we assent to and act upon is true.

In the presence of uncertainty and in the preference to satisfy needs sooner rather than later, expediency is an issue when it comes to accepting ideas. We rarely can wait for absolute certainty. This certainty provided through theory deduced from axiomatic

[26] From Frege, *The basic Laws of Arithmetic: An Exposition of the System*, ed. and trans. M. Furth (Berkeley, Ca.: University of California Press, 1969). P. 13. As cited in David R. Cerbone, "How To Do

foundations, using proper logic, and forming conclusions is not always possible and takes time if it is possible. Often times we cannot wait for certainty that may take lifetimes to accomplish. Existing in the present and preferring sooner rather then later to satisfy our needs, expediency is a favorable goal and uncertainty is a risk worth taking.

As such, in sciences in which the proper foundations are problematic, we are forced by necessity and expedience to accept incomplete scientific paradigms. When needs progress to the point that a paradigm is viewed to be unable to satisfy future demands place upon it, some members of the scientific community will begin to leave the practices of normal science and begin the extraordinary practice of developing new paradigms to satisfy future demands. If their predictions are right and they produce a paradigm that is perceived to be better in satisfying future human needs than the old paradigm, then scientific revolution may take place on the initiative of the scientific community itself.

If however, the community is in error in continuing to accept an older paradigm that is incapable of satisfying future human needs and the demands placed upon it by its demanders, the supply of goods and services, psychic and physical, the scientists are able to command through their work within the paradigm will fall. When these rewards fail to meet the expectations of those who accepted the dominant paradigm scientists within the paradigm will be disgruntled. This may cause reevaluation in the field regarding future benefits derived from the practicing of the paradigm. While past errors are no indication of future failure, the judgment that resulted in prior decisions has proved to be wrong.

Things with Wood: Wittgenstein, Frege, and the Problem of Illogical Thought", *The New Wittgenstien*, ed. A Crary and R. Read (London: Routledge, 2000).

New entrants seeing the errors of their teachers may view an alternative paradigm as be better suited to the future demands of user's of scientific research and theories. In this event, scientific revolution will take place. There may always be holdouts, as we said before paradigm acceptance is based on usefulness, not necessarily truthfulness. However, a new majority of scientists will emerge with a different but dominant paradigm.

This shift in paradigm in no way implies ex-ante a superior move, either in terms of moving towards the truth, or as being a beneficial move in terms of mankind, or the demanders of scientific research and theories. It is only after the fact that we can decide this question. The answer is difficult, what must be determined in the change of paradigm in an incomplete science is whether or not a greater number of human needs can be accomplished as a result of paradigm change. Are the values of the problems solved by the new paradigm more valuable or less than the problems that could only be answered under the old? Even this may not be sufficient; the acceptance of Einsteinian relativity theory did not displace Newtonian physics completely. There are elements of Newtonian theory that people still find useful. One of the key problems in comparing paradigms is that scientific research and theories are not depletable. Once they are known, they do not depreciate. Once known a theory or scientific research goes from being an economic good to a free good for the possessor. Even if the causal relationship or thing the theory discusses do not exist as stated, it may be useful. In being useful, and known, it is no longer the subject of scientific research, whether in an incomplete or complete science. Science deals with discovery, not practical application. Technology is the practical application of science, complete or incomplete.

Incommensurability is not a hindrance to the determination of progress of science. Progress is a term related to science in the following ways. In a complete science, one of axiomatic foundations, the addition of new axioms, or the application of logic to new combinations of axiomatic statements is progress. In the incomplete sciences, progress is in the integration of axiomatic statements, or the increased number of human needs that can be satisfies by the changes in a paradigm. While it is not asserted any where that the works of Einstein are true, we have seen increases in the number of goods now producible as a result of his theory, nuclear power as one example. Unfortunately, we may not know what rejecting previous paradigms lost. If error is present in a paradigm shift, only after the error has been corrected can we know what was lost. To know if a paradigm shift was progress, we would have to know what progress is. As a result, the acceptance of incomplete science cannot be judged under the Incommensurability criteria that Kuhn pursues. In this regard, incomplete science is not in the business of producing philosophical truths, but acting in an expedient manner to satisfy human needs. As such, the act of judgment is the determination of paradigm acceptance. We cannot compare paradigms internally to judge them. Rather one must look at technological advances made as a result of paradigm shifts and determine the value of these advances over advances that could have been or are made by the old paradigm. This view is complimentary to that discussed earlier by Hans-Hermann Hoppe.

> The relativistic impression of the development of the empirical natural sciences that Kuhn and Feyerabend try to convey is due to the fact that they both ultimately misconceive of scientific theories as mere systems of verbal propositions and systematically ignore their foundation in the reality of action. Only if one regards theories as being completely detached from action does any single theory not only become immunizable, but any two rival theories whose respective terms cannot be reduced to and defined in terms of each other must then appear incommensurable so as to exclude any rational choice between them. However, this affects neither the refutability of any one theory, nor the commensurability of rival paradigms, on the entirely different level of applying them in the reality of action, of using them as instruments for the attainment of a

> practical purpose. On the level of mere words, paradigms may be irrefutable and incommensurable, but in practice they never can be. In fact, one could not even state that any single paradigm was irrefutable or any two paradigms were incommensurable and in what respect, unless one presupposed a common categorical framework that could serve as the basis for such an assessment or comparison. And it is this *practical* refutability and commensurability of the paradigms of the empirical natural sciences that explains the possibility of technological progress.
>
> In systematically ignoring the fact that theories and theoretical interpreted observations are those of an actor, built and made in order to act successfully, Kuhn and Feyerabend have deprived themselves of the very criterion against which all knowledge concerning nature is continually tested and commensurated: the criterion of successfully reaching a set goal by applying knowledge in a given situation, or failing to do so. Without the criterion of instrumental success, relativism would seem inescapable. Yet in each of our actions vis-à-vis nature, we confirm the claim of rationalism that one can identify a range of application for some theoretical knowledge and test it for its success within this range, and hence, that competing theories must be considered commensurable as regards such range of application and success. No situation is conceivable in which it would be rational to give up an intellectual tool which had proven successful in a range of application if no better tool were available. Yet if a superior tool were available, for example, a theory or paradigm that allowed one to reach a goal that could not be reached equally successful by applying another, incompatible theory, it would be irrational for an actor not to adopt it. To be sure, such irrational behavior is empirically possible. However, whoever chose it would have to pay a price for doing so. He would deprive himself of the ability to achieve goals that he otherwise could accomplish; and isolated from all social contexts which might offer other, socio-psychological reasons not to adopt it, alone vis-à-vis nature, no one capable of distinguishing between successful and unsuccessful action would ever want to pay such a price. It is this which explains the unacceptability of a relativist view of the natural sciences and the possibility of the actually observable continues –if at times for socio-psychological reasons somewhat erratic –progress in man's mastery of nature, which Kuhn and Feyerabend would declare non-existent, although all the while it seems to staring them in the face.[27]

Kuhn in ignoring that science is an action and directed towards the satisfaction of human needs is led from his conclusion of the incommensurability, from a logical level, of the different empirical natural sciences he examines, is led to dismiss the advance of these sciences. As we have noted earlier, if a science were true, or complete, then such an exercise might be done, to look at a paradigm and its successor then compare what is contained in the first paradigm, them subtract this from the following paradigm. The only possibility for advancement would be the addition of a new axiom and the relating of this new axiom to the older set. As long as no axiom contained in the first paradigm were

[27] Hans-Hermann Hoppe, *The Economics and Ethics of Private Property* (Boston: Kluwer Academic Publishers, 1993). P. 211-13.

given up, then we could, from a logical point of view, determine if a paradigm were and advancement over the previous. We could in essence add up the new truths possible. However, these types of changes would not be incommensurable.

In the empirical physical sciences that Kuhn examines, the foundations of the paradigm and some of the objects under investigation are problematic in these incomplete sciences. In this case, the theories and research done in light of and guided by the expectations of the theory are not known. They cannot be refuted or proved using the scientific method. There may always be variables that affect the experiments they try to control that they do not know of, or have not controlled for. These paradigms are expedient theories directed towards the satisfaction of human needs. As such, it is entirely possible and logical that one paradigm may be given up for one that is incommensurable. This in no way is a denial of progress, or the ability to determine progress. It is a different standard by which incomplete scientific paradigms must be judged. In the absence of any necessary truths in their initial assumptions, the usefulness of the theory and the inclusion of observation under taken with instruments designed on the basis of a priori science such as protophysics. In this case, the progress of a science can be judged. As time has progressed, there is a clear extension of mankind's mastery over the physical world. This is blatantly obvious.

This in no way implies that this progress has been continual; however, the market test ensures feedback on prior decisions. It is possible that socio-psychological factors can inhibit such development. It is even possible that science can regress in places where institutional factors send scientists off on the wrong track. However, even here the individuals in these institutions or those who adhere to them view them as more

important than scientific research in paradigms that are not acknowledged or supported through the institution. In addition, as markets expand and civilization advances, this will tend to minimize error and increase the number of true goods available to a society. As civilizations regress, due to a reduction in markets and the division of labor and specialization that follow from them we would expect to see an increase in the number of imaginary goods produced. Institutions, governments included, that tend to reduce the extent of the market and the division of labor and specialization must cause a reduction in the progress of civilization, relative to the absence of such an institution.

This reduction in the progress of civilization and the division of labor and specialization would tend to reduce the quantity of savings and capital in a society.

> It is certainly true, and noteworthy, that losses of knowledge can occur even in the natural sciences, and that it is therefore profitable to study not only the most recent publications in one's field, but also the writings of authors long past and forgotten. It is also true that motives such as power, prestige, income, animosity, and friendship do not become inoperative once people turn to the study of nature. . . . Indeed, as an economist one can go further and admit the possibility of scientific regression: A process of capital consumption, followed by lower general standards of living, a reduction in population, a disintegration of markets, and the division of labor, as has repeatedly occurred in the history of mankind, would inevitably result in a decrease in man's knowledge of nature.[28]

[28] Hans-Hermann Hoppe, *The Economics and Ethics of Private Property* (Boston: Kluwer Academic Publishers, 1993). P. 211.

CHAPTER V: THE RISE OF MATHEMATICAL ECONOMICS IN UNITED STATES (1870- 1970)

In this chapter, the theory put forth in chapters I through IV will be applied to recent history.[1] An exact timing of the rise of mathematical economics is a difficult task, however, data regarding the types of economics articles written, the number of economists and other data regarding the economics profession will be examined in relation to the theory discussed in earlier chapters. In addition, the writing of historians of economic thought as well as historical events will be used as further evidence of the change in the economics profession towards a mathematical consensus.

The rise of the state will be examined. One component of the theory outlined in prior chapters is that as the state grows, certain problems arise in relating the benefits of an action with the costs. These problems will be reexamined and addressed in relation to the characteristics of mathematical economics.

The dramatic rise of the size and scope of government in the United States of America during the period under discussion will be put forward. This rise in government activism in the US comes with an increased need for predictions and estimations of economic variables, which no longer present in the market, must be accounted for in order to justify and manage state interventions. The growth of federal, state and local governments, created demand for economic theory and practices that accommodated the

[1] Roughly 1870 to 1970. The main emphasis will be the assertion that mathematical economics rise is roughly tied to the 1930s. Its rise is attributable to the rise of the state and large corporate entities reliant on government corporate laws, specifically limited liability.

need of the state to estimate and predict economic variables, in order to justify and manage its activities.

The growth of corporate involvement in the economy will be addressed. The increase in the use of large-scale corporate entities to conduct business in the US, especially in the form that utilizes vertically integrated production processes, increases the demand for prediction and estimation of economic variables. These predictions and estimates are again used to manage and justify the actions of corporate managers to their stockholders and to state institutions.

Next, institutions of higher learning will also be taken into consideration. One key element will be its funding. An examination of the funding of higher education will be undertaken. We will see that over the time period considered that funding from government and corporate sources has increased in relation to student fees. This increase in the relative shares of funding sources for higher learning should shed some light on to the influences these institution have in directing educational institutions to produce students learned in the methods and equipped with the tools needed by corporate and governmental institutions to satisfy their long-term goals. This influence can be related to the economics profession.

The increases in funding for higher education and the demand for administrators and managers acquainted with ‘scientific management’ techniques will be examined in the growth of higher education. We will see that between 1900 and 1970, there were large-scale increases in the resources used to provide higher education services. We see not just an increase in resources, but that these increases are disproportional to the over

all increase in resources in the US economy. Resources were not just being added, but shifted from other uses into the field of higher education.

Finally, with the information regarding the increase in size and scope of government, and corporate activities over the period, the profession of economics will be examined. The changes that took place over the twentieth century will be related to the theory laid out in chapter four. The increase in the use of mathematic techniques over the twentieth century will demonstrate the timetable for the already obvious ascension of mathematical economics into a dominant paradigm. The changes in employment possibilities for economists will demonstrate the increasing role the state and corporation have in employing economists. In accordance with this information, economists have become more interested in accommodating the goals and research agendas that involve state and corporate issues. Thus, it would necessitate a paradigm that answers questions that deal with the prediction and estimation of economic variables that are not present, explicitly, due to the absence of market prices.

In such an environment, a paradigm that provided acceptable answers to such questions would rise in prominence versus those that could not provide such answers. Paradigms that question the growth of the state and its dependent, the modern corporation would decrease in prominence.

In the end, evidence from historical experience will be seen as supporting the theory laid out earlier. The growth in the state and large corporate entities led to an increased demand for predictions and estimates of economic variables not explicitly provided through market prices. As such, government and corporate involvement with funding higher education led to a harmonization of interests between higher education

and its benefactors. Government and corporate hiring of the graduates of these universities increases the demand for a paradigm that can accommodate the interests of state and corporate managers and politicians to provide estimates and predictions. Over the period examined, economic paradigms of mathematical orientation rise to becoming the dominant form of economic research. Journals and articles reflecting the mathematical methods outweigh those that do not in importance and quantity.

The claim that the historical evidence shown proves the theory laid out is not made. Rather only that the evidence coincides with the implications of the theory. There are gaps in the evidence. One such gap is the absence of financial data for economics departments themselves over this period. No such data exists in a form that was obtainable within the resource constraints of this work. However, the main issue of this dissertation is not to prove anything, rather to develop a consistent theory of the history of scientific revolution, relying on sound philosophical judgment, the already present works of Thomas Kuhn, and economic theory.

Once such a theory was derived, it was necessary to apply this theory to a topic of interest. The topic chosen was the rise of mathematical economics in the United States of America. This topic was an area that the theory demonstrates was the result of changes in institutions within the United States, specifically the growth of the state and its dependent, the modern corporate entity. This is not to say that these institutions are the only ones capable of fomenting scientific revolutions. Rather, only in this case, the rise of the state and corporate activities led to a paradigm shift towards mathematical economic paradigms.

Implications From Our Theory

Implication from the theory laid out in chapter 4 are based on the idea that science is a producer's good, supplied on intellectual markets. These marketplaces include universities, corporate and governmental research centers, book publishing, and journal articles anywhere ideas are exchanged. As such, scientist do not, except in the case individuals who do not care about the acceptance of their theories by anyone else, produce theories to suit their own needs, but theories that are demanded by others. These theories may lead to new consumer's goods, or producer's goods that eventually lead to the production of a consumer's good. Regardless, scientists supply ideas to others.

Scientists are not reliant upon outsiders to purchase, and thus fund their research and lifestyles, the types of research they undertake are determined by the needs of others. Thus, influences outside the scientific community are heavily influential as to what types of research scientists undertake. Institutions outside the scientific community have needs for research that correspond to their own nature and needs. A steel firm would require scientific theories that it can use to make steel of higher quality, at lower costs, or in greater quantities. It would not be interested in theories that produce higher costs, lower qualities and lower quantities.

Institutions have a huge role to play in the demands placed upon science. An institution that is based on the ideas that stem cell research is an absolute wrong, would not fund, or purchase scientific research that involved stem cell research. If this institution were to remain small, both financially and in its overall influence, this may not have much of an effect on biological research involving stem cells. However, if it were to become highly influential and be a major purchaser of scientific research, then its

influence would be felt on the scientific community. For example, if this institution were to purchase and fund large amounts of scientific research and make a point of banning any researcher who used stem cells in their research from funding; this would tend to shift research away from the use of stem cells into other pursuits.

Churches, governments, and other large institutions have had huge influences into determining what is scientific and what is done in research institutions. The larger an institution gets in its influence and resources, the greater power it will have on the scientific community.

Rise of Mathematical Economics

In terms of the rise of mathematical economics, the growth of government and corporate institutions leads to a shift in the economics profession towards a paradigm that produces predictions and estimates that can be used by planners to manage in the absence of certain market data and by policy makers to justify and develop new programs and plans. The paradigm that supplied these goods best was one that relied on mathematical and positivistic methods. The rise of the state and the large corporation during the 20th century led to a paradigm shift in economics.

As such, it would be expected to see a large, accelerated growth in the relation of these two institutions at the expense of private, non-corporate institutions. An accelerated growth pattern relative to the private non-corporate sector would be indicative of such an event. As state and corporate institutions expand at an accelerated rate, they gain at the expense of non-corporate private institutions[2] producing new demands upon science and economics in particular.[3]

[2] While there are ethical implications that may go along with this change, it is merely being asserted here that such a change has taken place, good or bad, and that such a change has certain implications due to the

Expectations

This chapter will examine the growth of the state, and corporate institutions and the effects this caused on higher education and the economics profession. The growth of the state will be examined. A significant change in the size and relation of the state to the private sector will be looked for. If found, this would indicate, according to the theory laid out, that this would tend to place demands for the estimates and prediction discussed earlier. It will be shown that a change occurred in the 1930s and 1940s continuing to the 1970s.[4] Government took an increased role in the control of resources and this change took place at an accelerated rate during the 1930s and 1940s.

The theory would also indicate an increase in government purchasing of higher educational products. This includes theories, research, and students trained to perform it. Policy makers and planners trained to satisfy the needs of those who control and manage the state. This topic will be examined when Higher education is discussed. Were there large-scale changes in the funding of higher education institutions? We would expect to see a shift in funding patterns around the same time that government growth takes off.

The large corporation with its separation of management and ownership will also be examined. The separation of ownership and management along with vertical integration produce specific demands for mathematical methods in economics. Predictions are used to justify management actions to owners and prospective owners, and estimates of variables no longer available through the pricing system are needed by

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nature of these institutions, and that this change exerts a change in the demands placed on the education/ research system, in our case specifically on the economics profession.

[3] This change has produced new demands on other branches of science; however, the subject matter here is limited to those relating to the profession.

[4] The year 1970 was used as a cut off, the trends seen then continue to today, but a discussion of this was irrelevant to the theory being examined.

the large corporate institution under vertical integration. During the 1930s and 1940s, we expect to see large-scale acceleration in the relationship between corporate and non-corporate production and control of resources.

Such a change has occurred in the United States and we would expect to see a change in the proportion and quantity of corporate spending on higher education in the same manner that was discussed for government. This will be examined in the section discussing higher education.

The higher education system will also be examined. In doing so, a few areas will be of interest in relation to the theory outlined above. In the presence of large government and corporate institutions, it would be expected that there be a shift in university funding from private non-corporate sources (student fees and other private non-corporate funding) to government and corporate funding. This will be shown to take place in accordance with the time frame of government and corporate growth. A shift in funding sources will indicate a change in the ends towards which scientific research in directed. The direction will be in the direction of government and corporate needs at the expense of private non-corporate demands.

The final section of this study will examine the economics profession as a whole. We will look for a shift of economic research from the independent scholar to the university professor and examine the output of economists in the form of journal articles. When do economic journal articles begin to be mathematical in their nature and does this shift occur in a time frame that is reasonable with the institutional changes outline above?

Rise of the State

The large growth in government in the twentieth century is an obvious fact. The growth in government in the United States of America is a given during the period 1900 to 1970. The purpose of this inquiry is to place a time frame for the acceleration of government growth that would tie it to the rise of mathematical economics in the United States. In order to do this; a brief description of governmental growth (federal, state and local) must be done. To do this it would first seem necessary to come up with a measure of government.

There is no absolute measurement of government. As pointed out by Robert Higgs in *Crisis and Leviathan: Critical Episodes in the Growth of American Government*, many aspects of government "defy precise measurement."[5] Instead, Higgs uses three conventional methods of measuring government growth in the United States and puts forward an alternative measure.[6] Using the three conventional measures, a time period during which government growth accelerated will be used. The theory outlined in chapter four will be applied to this data. If we see a radical shift in government activities, this would coincide with the theoretical implications outlined previously. If the pattern of government activities were seen to dramatically increase at some point in time, this would tend to indicate an increased demand for the output of mathematical economics.

[5] Robert Higgs, *Crisis and Leviathan: Critical Episodes in the Growth of American Government* (New York: Oxford University Press, 1987), p. 20. This section of the dissertation will rely heavily on Dr. Higgs work, since his goal to examine periods of governmental growth and ours are similar.
[6] Ibid., pp. 20-34. I will not make an effort to put forward which measure of government is best, etc. . . . Rather, I will use all the measures mentioned above to come up with a time period within which government growth patterns changed.

In this section, various measures of government growth will be used to come up with a timetable for the accelerated growth in government. While no accurate measure of government size exists, various imperfect measures will be used to not quantify the increase and acceleration of the size of government, but rather to time it. To do this a number of measures will be examined to discover a rough time period for this event. Real government consumption expenditure and gross investment will be examined to time government's rise and absolute increases in its fiscal power. This will be useful in timing the accelerated growth in government and get an idea as to how government spending has increased over the period 1900 to 1970.

Federal government consumption expenditures and gross investment will then be compared to State and Local consumption expenditures and gross investment spending. This will illuminate the sources of government growth and be a good indication if such growth is concentrated at the federal level versus the state and local level. If such growth were concentrated at the federal level, the federal government would be a better engine through which nationwide changes in demand for economic predictions and estimates could spread throughout the profession.

Government purchases as a percentage of GNP figures will indicate the proportion of national product spent by governments (federal, state, and local) of national product. This statistic will give us an indication of the scope of government versus the private sector. If this figure increases this will mean that government is growing at a faster rate than the economy as a whole, and as such, more activities will come under the control of government relative to the private sector.

Paid civilian employment of the federal government and paid civilian employment, as a percentage of the workforce will be looked into. This statistic will indicate the rise in resources being put into government production and its relationship to the private sector. As these figures increase, it indicates a great proportion of resources being placed into government rather than private production. This indicates a greater role over time of government decision-makers and managers controlling a greater portion of the nation's resources. It indicates a shift of resources that would have gone into the private sector into government sectors. This would lead to a greater need on behalf of government planners to replace missing variables and for predictions on future values for its service. This data will also be used to add credence to the 1930s and 1940s being the period during which government accelerated growth took place.

With all of this data considered, we will examine when government growth accelerated, get an idea as to the scope of this growth and be able to come up with an idea as to whether this growth occurred on the federal, state and/or local level? What sectors grew more than others, and determines whether greater shares of resources are being put to use within the government?

Table 5-1.

Title:	Real Government Consumption Expenditures & Gross Investment
Series ID:	GCECA
Source:	U.S. Department of Commerce: Bureau of Economic Analysis
Release:	**Gross Domestic Product**
Seasonal Adjustment:	**Not Applicable**
Frequency:	**Annual**
Units:	**Billions of Chained 2000 Dollars**
Date Range:	**1929-01-01 to 2004-01-01**

Last Updated: 2005-12-05 1:50 PM CT
Notes: A Guide to the National Income and Product Accounts of the United States (NIPA) - (http://www.bea.doc.gov/bea/an/nipaguid.pdf)

DATE	VALUE
1929-01-01	120.6
1930-01-01	132.9
1931-01-01	138.5
1932-01-01	133.8
1933-01-01	129.2
1934-01-01	145.7
1935-01-01	149.7
1936-01-01	174.7
1937-01-01	167.3
1938-01-01	180.2
1939-01-01	196.0
1940-01-01	201.5
1941-01-01	335.1
1942-01-01	788.6
1943-01-01	1173.3
1944-01-01	1320.5
1945-01-01	1152.9
1946-01-01	396.8
1947-01-01	337.2
1948-01-01	361.7
1949-01-01	404.9
1950-01-01	405.3
1951-01-01	553.5
1952-01-01	666.3
1953-01-01	713.9
1954-01-01	665.1
1955-01-01	640.7
1956-01-01	641.0
1957-01-01	669.5
1958-01-01	690.9
1959-01-01	714.3
1960-01-01	715.4
1961-01-01	751.3
1962-01-01	797.6
1963-01-01	818.1
1964-01-01	836.1
1965-01-01	861.3
1966-01-01	937.1
1967-01-01	1008.9

1968-01-01 1040.5
1969-01-01 1038.0
1970-01-01 1012.9

The initial look at government growth will be an inquiry into the absolute growth of government expenditures on consumption expenditures and gross investment. This statistic while not extremely useful in timing the rise of government is of some use. In addition, the statistic allows a comparison of federal versus state and local spending. If the absolute quantity of all government consumption expenditures and gross investment spending increases, and the proportion of this overall government spending by the federal government increase as well, this would indicate a growing government that is being centralized at the federal level. This statistic is a conservative estimate of this centralization due to the presence of federal grants to state and local governments that are actually federal tax revenues sent back to state and local governments that show up as increased state spending.

Real government consumption and investment spending reached its high in 1944 during the Second World War at 1320.5 billion chained 2000 dollars. We will leave out the war years in our inquiry, as spending quickly rose during the war and then declined dramatically afterwards. The spending patterns before and after wars are the types of spending that indicate a trend of increased government activities in the day-to-day running of the economy. The war years (Second World War, Korean Conflict and the Vietnam War) are indications of spending that has a temporary effect on the economy; the types of spending incurred (for active armies and armaments) are tied to specific

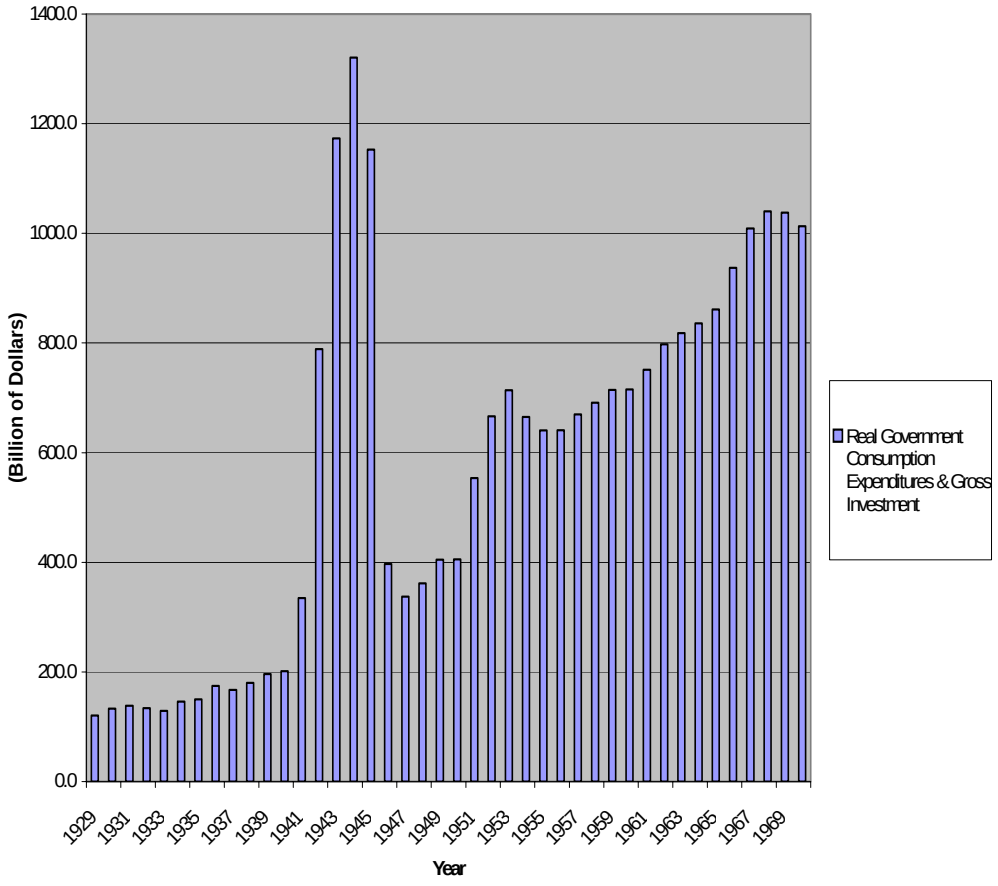
short-term events. I am interested in the long-term trends for government spending related to interventions in the economy.[7]

Using the real government consumption expenditures and gross investment figures in the table above, it can be seen that real government consumption expenditures and gross investment spending has increases from 120.6 billion chained 2000 dollars in 1929 to 1012.9 billion chained 2000 dollars in 1970. This is a 739.88% increase over the 42-year period.[8] Averaged over the 42-year period, this comes to a 17.62% increase per year.

This data indicates the large increase in real consumption expenditures and gross investment spending undertaken by governments over the period 1929 to 1970. This data is useful in describing the overall increase in government spending that has took place in the 1930s, 1940s, 1950s, and 1960s. Government grew that is a fact. This investigation requires much more information. The data from the table above is put into graphical form in the graph below.

[7] The war years throughout the dissertation will be treated in the same way.
[8] Unfortunately, numbers prior to 1929 were not available.

Figure 5-1: Real Government Consumption Expenditures & Gross Investment



The chart above documents the growth of government consumption expenditures and gross investment spending over the period 1929 to 1970. This tremendous growth has resulted in peacetime levels of real spending that come close to matching levels of real government consumption expenditures and gross investment spending figures of the Second World War. This large-scale growth is one factor that has lead to the rise of mathematical economics during the same period. As government growth takes off, the need for predictions and estimates of economic variables, lost due to removal of resources from the market economy and their being placed into government production, becomes important for government planners and policy-makers.

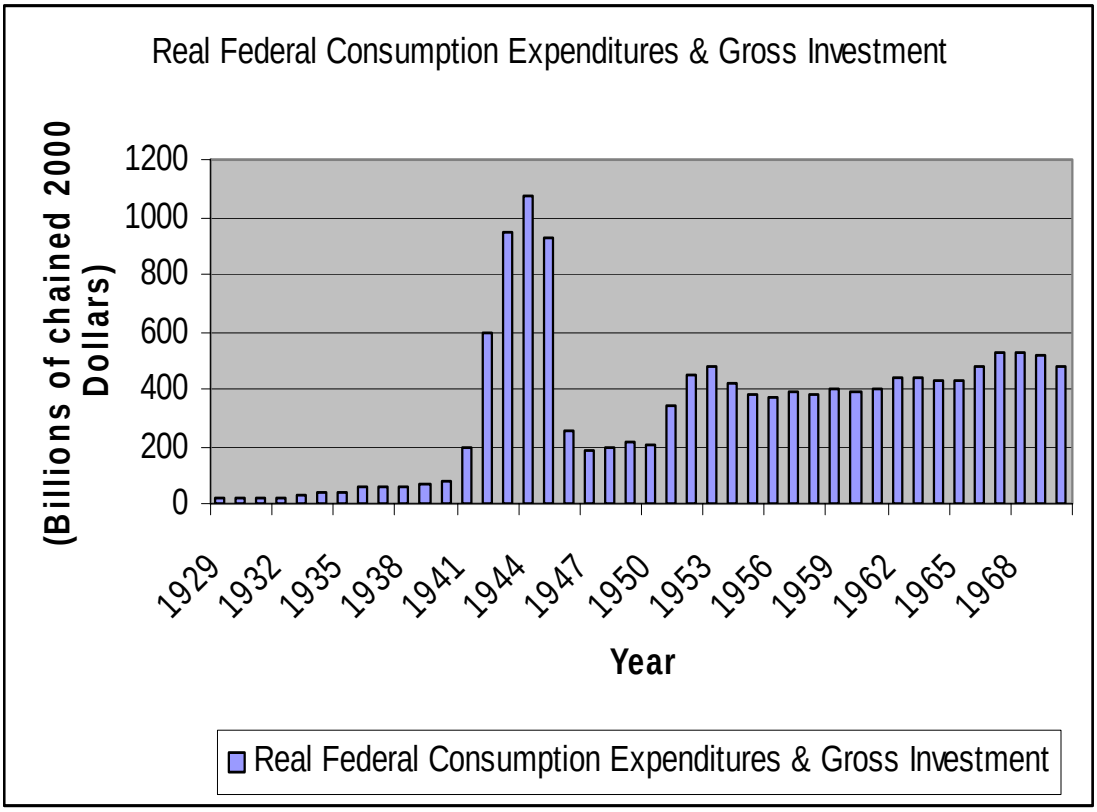
Table 5-2

Title:	Real Federal Consumption Expenditures & Gross Investment
Series ID:	FGCECA
Source:	U.S. Department of Commerce: Bureau of Economic Analysis
Release:	Gross Domestic Product
Seasonal Adjustment:	Not Applicable
Frequency:	Annual
Units:	Billions of Chained 2000 Dollars
Date Range:	1929-01-01 to 2004-01-01
Last Updated:	2005-12-05 1:50 PM CT
Notes:	
	States (NIPA) - (http://www.bea.doc.gov/bea/an/nipaguid.pdf)

DATE	VALUE
1929-01-01	20.6
1930-01-01	22.8
1931-01-01	23.6
1932-01-01	24.2
1933-01-01	29.9
1934-01-01	40.1
1935-01-01	40.8
1936-01-01	61.6
1937-01-01	55.4
1938-01-01	61.2
1939-01-01	65.7
1940-01-01	73.5
1941-01-01	194.0
1942-01-01	595.9
1943-01-01	942.6
1944-01-01	1076.0
1945-01-01	924.3
1946-01-01	248.9
1947-01-01	183.9
1948-01-01	198.4
1949-01-01	217.8
1950-01-01	205.8
1951-01-01	341.5
1952-01-01	444.2
1953-01-01	480.0
1954-01-01	417.0
1955-01-01	379.1

1956-01-01	372.4
1957-01-01	385.6
1958-01-01	385.3
1959-01-01	397.4
1960-01-01	386.5
1961-01-01	402.6
1962-01-01	436.9
1963-01-01	437.2
1964-01-01	431.4
1965-01-01	431.2
1966-01-01	478.9
1967-01-01	526.5
1968-01-01	530.6
1969-01-01	512.4
1970-01-01	474.6

Figure 5-2.



Real federal government consumption expenditures and gross investment over the period 1929 to 1970 increased by 2203.88%, a 22-fold increase in federal consumption expenditures and gross investment over the period. The chart indicates acceleration in growth beginning in the 1930s (around 1933) and accelerating at an increasing rate up until the 1950s. This large scale systematic growth in federal consumption expenditures and gross investment spending indicates a significantly larger growth rate in federal government consumption expenditures and gross investment spending (2203.88%) over the period than for government consumption expenditures and gross investment spending as a whole, including state and local governments, which was (739.88%) over the same period. This data will be compared with the growth in consumption expenditures and gross investment spending by state and local governments.

Real State and Local Consumption Expenditure and Gross Investment

Table 5-3. is the real state and local consumption expenditures and gross investment between 1929 and 1970. This data will give a description of state fiscal spending growth during the period. The data will enable us to compare state and local government growth with federal growth.

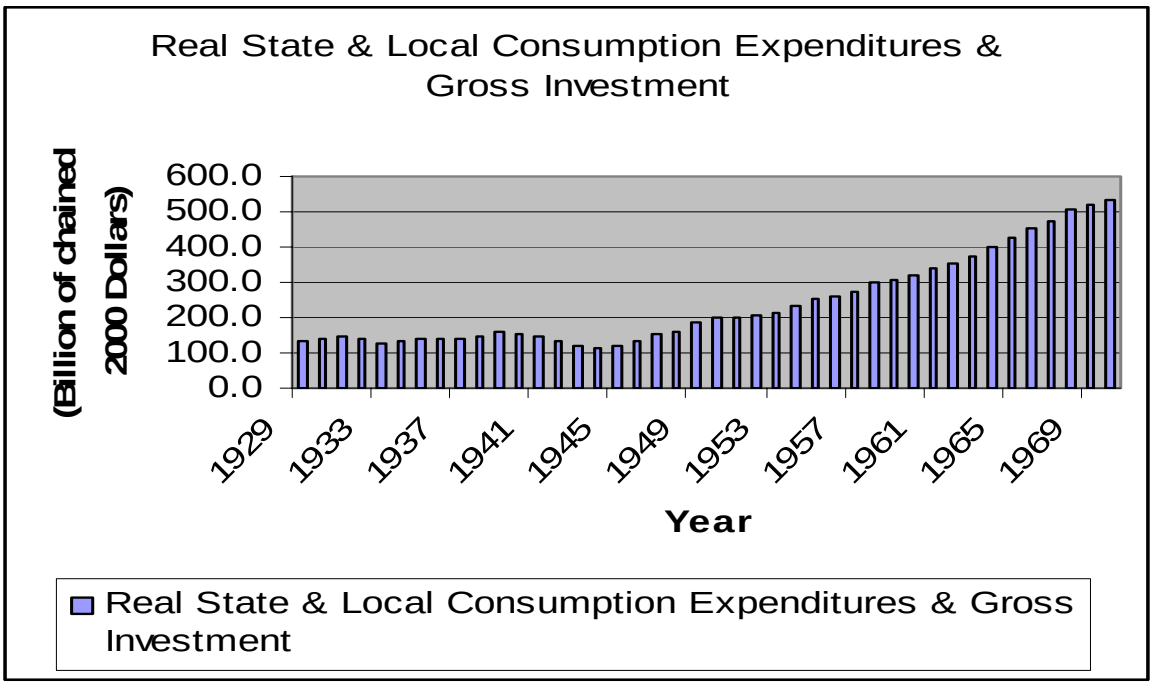
Table 5-3.

Title:	
Series ID:	SLCECA
Source:	U.S. Department of Commerce: Bureau of Economic Analysis
Release:	Gross Domestic Product
Seasonal Adjustment:	Not Applicable
Frequency:	Annual
Units:	Billions of Chained 2000 Dollars
Date Range:	1929-01-01 to 2004-01-01
Last Updated:	2005-12-05 1:50 PM CT
Notes:	A Guide to the National Income and Product Accounts of the United States (NIPA) - (http://www.bea.doc.gov/bea/an/nipaguid.pdf)

DATE	VALUE
1929-01-01	130.1
1930-01-01	143.2
1931-01-01	149.4
1932-01-01	142.5
1933-01-01	127.3
1934-01-01	133.9
1935-01-01	138.1
1936-01-01	138.9
1937-01-01	138.9
1938-01-01	147.1
1939-01-01	161.7
1940-01-01	156.3
1941-01-01	146.4
1942-01-01	132.8
1943-01-01	120.6
1944-01-01	116.4
1945-01-01	120.4
1946-01-01	132.4
1947-01-01	150.8
1948-01-01	160.4
1949-01-01	184.8
1950-01-01	200.0
1951-01-01	201.5
1952-01-01	204.9
1953-01-01	215.0
1954-01-01	233.8
1955-01-01	250.7
1956-01-01	258.8
1957-01-01	274.1
1958-01-01	297.4
1959-01-01	308.6
1960-01-01	322.1
1961-01-01	341.9
1962-01-01	352.4
1963-01-01	373.7

1964-01-01	399.0
1965-01-01	425.7
1966-01-01	452.4
1967-01-01	475.3
1968-01-01	503.4
1969-01-01	520.4
1970-01-01	534.8

Figure 5-3.



Over the period 1929 to 1933 state and local expenditures declined 2.15% averaged to -0.54% per year. This is in stark contrast to the growth in state spending over the period of 1929 to 1939 which grew 24.29% an average of 2.43% per year over the 10-year period. During the period, 1939 to 1949 state and local expenditures rose 14.29% over the 10-year period an average of 1.43% over the period. Some of the slowdown in state and local growth could be attributed to the crowding out of state and local governments by federal spending during the Second World War. When we examine the period 1949 to 1959 there was a 66.99% growth of state and local spending an average of 6.67% a year. The overall increase during the period 1929 to 1970 was 311.07% an

average of 7.59% per year. The growth of state and local spending is less than that of federal spending over the period which rose 740% over the year between 1929 and 1970.

The data does show that in absolute terms the fiscal spending of all levels of government increased. That federal spending increased at a higher rate than state and local government spending, and that the patterns of spending increases tend to be higher for federal levels than for local and state levels during the early part of the period (1929 to 1949).

Government Purchases of Goods and Services as a Percentage of GNP

One traditional measure of government is government purchases of goods and services as a percentage of GNP. This measure is a relation between the amount of spending by governments and the total dollar value of output by a nation. This measure is useful in determining the percentage of spending done by government relative to the private sector. As said earlier this measure does not account for dead-weight losses that occur because of government interventions, nor does it account for costs associated with complying with laws and regulations.

The statistic is useful in this study, in that changes in government spending as a percentage of GNP would be an indication of governmental growth, though not necessarily in a numerical sense. An increase in Government purchases of goods and services as a percent of GNP would lend itself to an increase in the size and activities of government. The use of the statistic here will be two-fold; one to gain an understanding of the magnitude, though imperfectly, of changes in the size and activities of government. Simply put large changes in the statistic would seem to indicate large changes in the size

and activities of government. The second useful piece of information would be the timing of such changes.

Table 5-4.

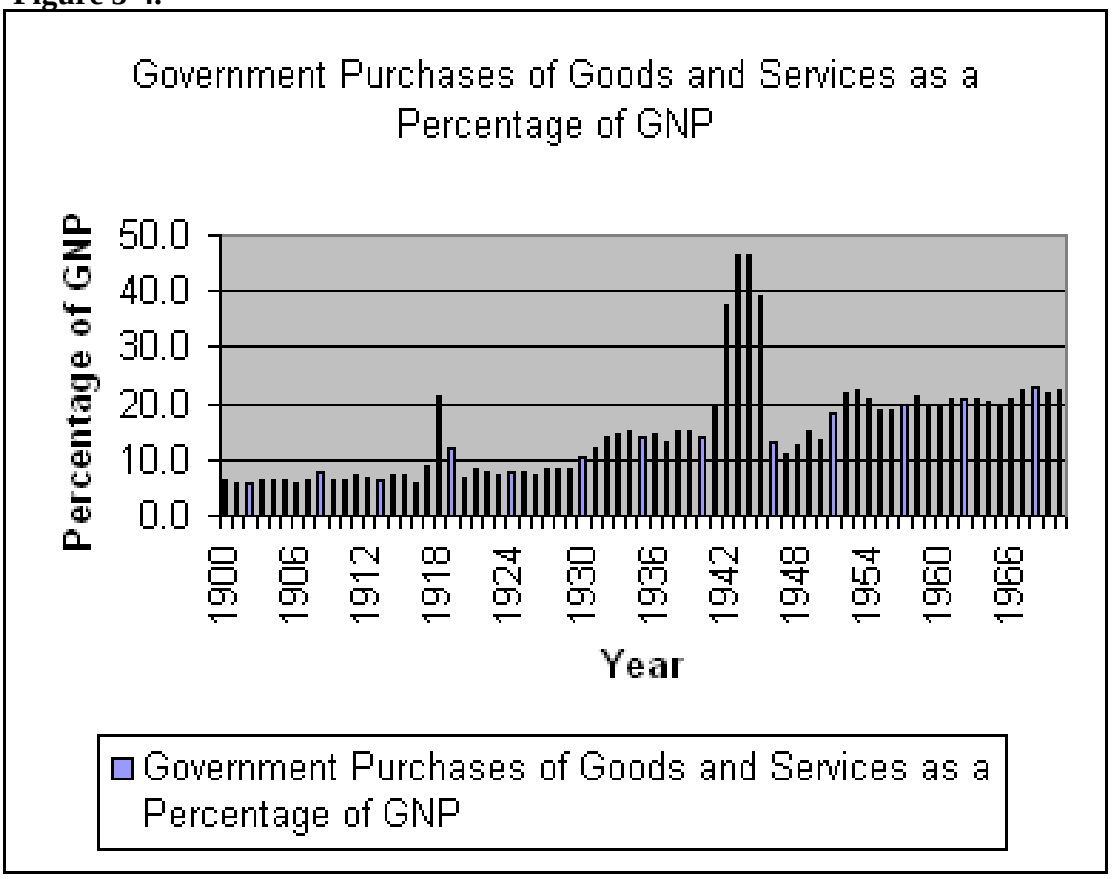
Government Purchases of Goods and Services as a Percentage of GNP[9]
1900 to 1984
Source: Robert Higgs, *Crisis and Leviathan: Critical Episodes in the Growth of American Government*

Year	Government Purchases of Goods and Services as a Percentage of GNP
1900	6.0
1901	5.6
1902	5.7
1903	6.2
1904	6.0
1905	6.1
1906	5.6
1907	6.2
1908	7.6
1909	6.0
1910	6.1
1911	7.2
1912	6.8
1913	6.4
1914	7.4
1915	7.2
1916	5.9
1917	8.9
1918	21.3
1919	12.0
1920	6.6
1921	8.5
1922	8.0
1923	7.2
1924	7.7
1925	7.9
1926	7.5
1927	8.2
1928	8.3
1929	8.1
1930	10.2
1931	12.1

[9] From Robert Higgs, *Crisis and Leviathan: Critical Episodes in the Growth of American Government* (New York: Oxford University Press, 1987). Pp. 22-23.

1932	14.0
1933	14.4
1934	15.1
1935	13.9
1936	14.5
1937	13.2
1938	15.3
1939	14.9
1940	14.2
1941	19.9
1942	37.7
1943	46.3
1944	46.1
1945	39.0
1946	13.1
1947	10.9
1948	12.3
1949	14.9
1950	13.4
1951	18.2
1952	21.7
1953	22.5
1954	20.7
1955	18.8
1956	18.8
1957	19.6
1958	21.1
1959	20.0
1960	19.8
1961	20.6
1962	20.9
1963	20.7
1964	20.4
1965	20.0
1966	21.0
1967	22.5
1968	22.8
1969	22.1
1970	22.2

Figure 5-4.



The data shows an increase in government purchases of goods and services as a percent of GNP over the period 1900 to 1970. Form 1900 to 1970, government purchases rose from 6.0% to 14.1%, a 135% increase. Other than during the war years of 1918 and 1919, government purchases were less than 10% of GNP up until 1929. From 1930 to 1939, government purchases as a percentage of GNP were in double digits but never more than 15%. During this period, government purchases as a percentage of GNP rose form 10.2% in 1930 reaching a high of 15.3% in 1938 and ending the period at 14.9%, a 46.08% change over the period. Meanwhile from 1900 to 1929, a 29-year period, the

percentage change in government purchases as a percentage of GNP rose only 35%.[10] Between the years 1930 and 1939 the percentage change of government purchases of goods and services as a percentage of GNP rose 11.08% more over a nine-year period than the same statistic rose over the 30 years prior. This is a clear acceleration in government growth taking place during the 1930s when discussing government expenditures as a percentage of GNP.

If we take this increase in government expenditures as a percent of GNP to represent a growth in government, the data clearly point to a rapid acceleration in the size and activities of government during the 1930s. Such acceleration would tend to support the growth of government and coincide with an increase in demand by governments for government goods. One of these government goods being estimates and predictions of economic variables lost due to the expansion of government production at the expense of private production.

[10] The percentage change of government purchases of goods and services as a percentage of GNP over a period was calculated using the following formula. (government purchases of goods and services as a percentage of GNP (end of period) - government purchases of goods and services as a percentage of GNP (beginning of period)] \ government purchases of goods and services as a percentage of GNP (beginning of period).

Table 5-5.

Series Y 308-317 Paid Civilian Employment of the Federal Government: 1901*** to 1970[11]
[As of June 30 except as noted]

Year	Total[1]	Washington DC[2]	All other Areas
1901	239476	28044	211432
1908	356754	34647	322107
1909	372379	35936	336443
1910	388708	38911	349797
1911	395905	39782	356123
1912	400150	38555	361595
1913	396494	38975	257519
1914	401887	40016	361871
1915	395429	41281	354148
1916	399381	41804	357577
1917	438500	48313	390187
1918	854500	120835	733665
1919	794271	106073	688198
1920	655265	94110	561155
1921	561142	82416	478726
1922	543507	73645	469862
1923	536900	70062	466838
1924	543484	68000	475484
1925	553045	67563	485482
1926	548713	64722	483991
1927	547127	63814	483313
1928	560772	65506	495266
1929	579559	68266	511293
1930	601319	73032	528287
1931	609746	76303	533443
1932	605496	73455	532041
1933	603587	70261	533326
1934	698649	94244	604405
1935	780582	108673	671909
1936	867432	122937	744495
1937	895993	117020	778973
1938	882226	120774	761482
1939	953891	129314	824577
1940	1042420	139770	902560
1941	1437682	190588	1247094
1942	2296384	276352	2020032
1943	3299414	284665	3014749
1944	3332356	276758	3055598
1945	3816310	264770	3551540

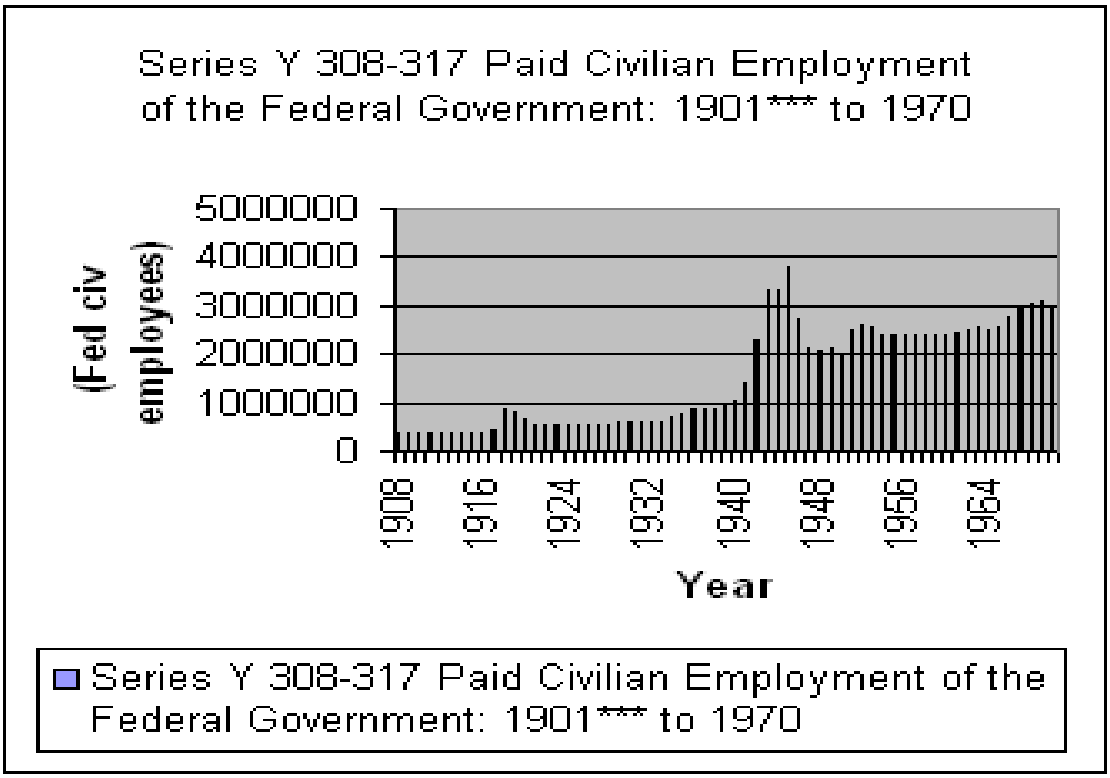
[11] U.S. Bureau of the Census, *Historical statistics of the United States, Colonial Times to 1970* (Washington D.C.: US Government Printing Office, 1975). P. 1103.

1946	2696529	242263	2454266
1947	2111001	213515	1897486
1948	2071009	214544	1856465
1949	2102109	225901	1876208
1950	1960708	223312	1737396
1951	2482666	265980	2216686
1952	2600612	261569	2339043
1953	2558416	242678	2315733
1954	2407676	228501	2179175
1955	2397309	231873	2165436
1956	2398736	232707	2166029
1957	2417565	236330	2181235
1958	2382491	230271	2152220
1959	2382807	234358	2148449
1960	2398704	239873	2158831
1961	2435804	246266	2189538
1962	2514197	257350	2256847
1963	2527960	266737	2261223
1964	2500503	269993	2230510
1965	2527915	279997	2247918
1966	2759019	299429	2459590
1967	3002461	318609	2683852
1968	3055212	329879	2725333
1969	3076414	328077	2748337
1970	2981574	327369	2654205

* The year 1919 As of Nov 11.
** The years 1920 and 1921 As of July 31.
*** Data Missing for years 1902-1907

In 1901, Paid Civilian Employment of the Federal Government was 239,476. By 1970, this figure had risen to 2,981,574. Over the period 1901 to 1970 federal civilian employment rose 2,742,098, an 1145% increase over the 69-year period. By 1970, there were more federal civilian employees working in Washington D.C. alone (327369) than worked for the entire federal government in 1901. US Population over the period 1901 to 1970 rose only 164%, during the period 1901 to 1970 the size of the federal government alone increased approximately 7 times faster than the population. This factor alone demonstrates the extraordinary growth of government during the 20th century.

Figure 5-5.



Between 1901 and 1929, federal civilian employment rose from 239,476 to 579,559, a 142% increase. In 1934, federal civilian employment rose to 601319, a 3.75% yearly increase. Between 1929 and 1939, federal civilian employment rose to 953,891, a 64.59% increase over the decade. Averaging out the percentage increases in government employees during the 1901 to 1929 period annually and for the 1929-to 1939 period, during the 1901 to 1929 period government civilian employment grew at an average annual rate of 4.89%, during the 1929 to 1939 period government civilian unemployment grew at an annual rate of 6.46%. In the 1939 to 1949 period, federal civilian unemployment grew 120.37% over the 10-year period. This is an average of 12.037% per year during the period. These numbers become more exaggerated during the 30s and 40s when one considers that total resident population grew 56.94% during the period 1901 to

1929, and only 7.48% during the 1929 to 1939 period. Total resident population grew by 13.59% during the 1939 to 1949 period. The information contained in federal civilian employment data becomes more evident when it is put forward as a percentage of the workforce.

Government Civilian Employees as a Percentage of the Workforce

To gain some perspective on the percentage of resources used by governments, government civilian employees as a percentage of the workforce is a useful measure. By describing the relative share of government employees relative to the workforce, this will be used as a proxy to the government's total share of resources. If the government's share of the workforce increases, it would indicate that resources are being shifted from idleness or private employment into government activities. The data listed in table 4 includes what were termed emergency workers from the period 1931 to 1943. These "emergency workers", were federal employees and such are classified as being civilian employees of the federal government. The data is inclusive of all government employees, federal, state, and local. Data were missing for the years 1901 to 1907. Chart 4 includes the year 1900 and skips the years 1901 to 1907.

Table 5-6.

Government Civilian Employees as Percentage of Civilian Labor Force 1900; 1908-1970

(Parenthetical figures include "emergency workers")
Source: Robert Higgs, Crisis and Leviathan: Critical Episodes
in the Growth of American Government
(New York: Oxford University Press, 1987) pp. 22-23.

Year*	Government Civilian Employees as a Percentage of Civilian Labor Force (Inc "emergency workers)**
1900	3.9
1908	4.3
1909	4.4
1910	4.4
1911	4.5
1912	4.5
1913	4.5
1914	4.6
1915	4.7
1916	4.8
1917	5
1918	6.3
1919	6.2
1920	5.7
1921	5.7
1922	5.8
1923	5.8
1924	6
1925	6.1
1926	6.3
1927	6.4
1928	6.5
1929	6.4
1930	6.5
1931	7.2
1932	7.6
1933	10.5
1934	12.1
1935	12.6
1936	14
1937	12.1
1938	13.7
1939	13.1
1940	12.6
1941	12.3
1942	11.3

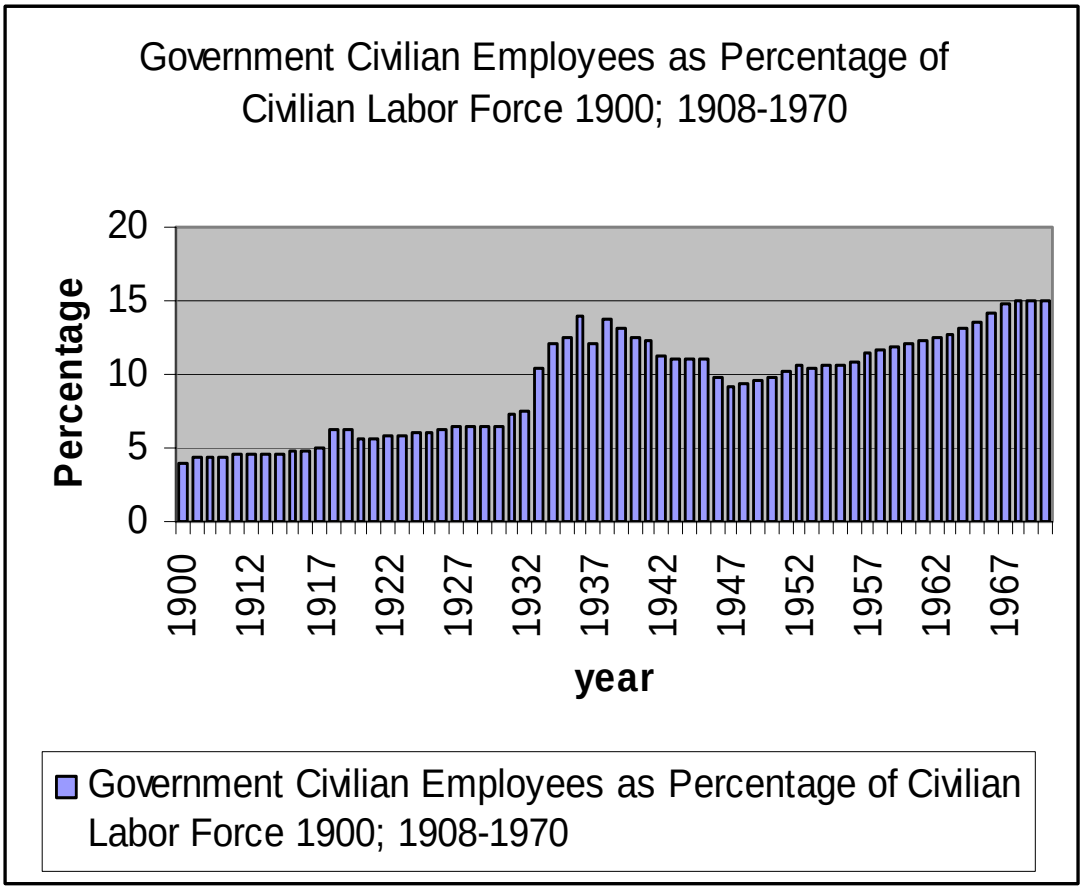
1943	11.1
1944	11.1
1945	11
1946	9.7
1947	9.1
1948	9.3
1949	9.6
1950	9.7
1951	10.3
1952	10.6
1953	10.5
1954	10.6
1955	10.6
1956	10.9
1957	11.4
1958	11.6
1959	11.8
1960	12
1961	12.2
1962	12.6
1963	12.8
1964	13.1
1965	13.5
1966	14.2
1967	14.7
1968	15
1969	15.1
1970	15.1

* Data Not available for years 1902 through 1907.
** Figures between 1931 and 1943 include "emergency workers."

The data from table 4 begins with government civilian employees as a percentage of the workforce at 3.9% of the total civilian workforce. The period ends in 1970 when 15.1% of the total workforce is employed in some way by federal, state, or local government. This is a 287.17% increase of government employment as a percentage of the workforce. This tends to indicate a large increase in the percentage of resources (labor in this case) from the private sector into the public sector. In 1900, roughly one in every 25 individuals in the workforce worked for some form of government. By 1970, 1 in

every 6.67 individuals in the workforce worked for a government entity. This data excludes those employed in the military, as well as those employed by private firms solely, or in part to comply with government regulations, or deal with government directly.

Figure 5-6.



Between 1900 and 1929, government civilian employees as a percentage of the workforce rose from 3.9% to 6.4%, a 64.10%[12] increase over a 29-year period. This averages to 2.21% increase per year. Over the period 1900 to 1970, the average increase in government civilian employees as a percentage of the workforce was 4.10% per year.

[12] The percentage change in government civilian employees as a percentage of the workforce (GCEPW) was calculated as follows: [GCEPW (end period) – GCEPW (beginning)] / GCEPW (beginning).

This shows that in the 41 years between 1929 and 1970, that the growth of government employment as a share of the economy accelerated.

For the years 1929 to 1939, government civilian employees as a percentage of the workforce increased from 6.4% to 13.1%, a 104.69% increase. For the years 1939 to 1949, government civilian employees as a percentage of the workforce decreased from 13.1% to 9.6% a decrease of 26.72%. This later figure is partially the result of elimination of “emergency workers” in 1943. Between 1949 and 1959, government civilian employees as a percentage of the workforce increased from 9.6% to 11.8%, a 22.92% increase. From 1959 to 1960, government civilian employees as a percentage of the workforce increased from 11.8% to 15.1%, a 27.97% increase. Average annual increases for the 1929 to 1939 period come to 10.47% a year.

The information above tends to collaborate with a large acceleration of government growth in the 1930s. While the information shows a decrease in government civilian employees as a percentage of the workforce in the 1939 to 1949 period this can be in part attributed to an elimination of “emergency workers, the acceleration in the 1949 to 1959, and 1959 to 1969, periods more than compensates for any reduction during the 1939 to 1949 period. In short, the process of government growth, at an accelerated rate over growth rates for the beginning 29 years of the century appears to begin in the 1930s.

Government Growth: The Data

Over the past 70 years, government growth has taken place at a very robust rate. The available data demonstrates that this growth has for the most part been the result of an accelerated growth rate beginning in the 1930s. The Great Depression, New Deal,

WW II, Korean Conflict, the War on Poverty, Great Society, the Vietnam War, the Cold War, and many other events have taken place during this time frame. Many different emergencies, or disasters, etc . . . . happened before the 1930s, it appears that some time after 1929 the role of dealing with those emergencies became a function of government to the extent that continued growth of the US government has changed the very nature of American life. Where at one time the only dealings a citizen might have with the federal government was on trips to the post office, dealings with the federal government has become an everyday matter of fact. One's employment, working conditions, the food he eats, the clothes he wears, and any other number of things are now regulated by the US government or a state, or local government.

Regardless of how one feels about this, it is another example of how government has grown in the United States. The data from government expenditures of goods and services as a percentage of GNP bears this out. Government's share of GNP has increased dramatically. This trend seems to have its beginnings in the 1930s. Government civilian employees as a percentage of the workforce increased 3.9% of the workforce to 15.1% over the period 1900 to 1970. This growth also seems to have accelerated in the 1930s.

This information will all be correlated to the growth of mathematical economics. An expansion of government activities will result in increased demand for predictions and estimates of economic variables that are absent in public provision of goods and services. The information normally contained in prices and produced by entrepreneurial decisions regarding profit and loss is no longer present. One can lament or praise this event that must take place when the state expands, but one cannot deny the fact that these

variables are not present and that a substitute for them must be supplied to make the claim of rational decision making on behalf of government planners and policy makers.

In the field of economics, paradigms that can best supply such services are at a premium to state planners and policy makers at the expense of those who cannot supply such services. Thus, the growth of government creates an increased demand upon paradigms that can supply these services at the expense of paradigms that cannot. Mathematical economics makes a claim to be able to supply the services that government planners and policy makers need and in a scientific, non-biased manner.[13]

Given the work done so far, an increased demand from government planners and policy makers for mathematical economics does take place in the 1930s.[14] A look must still be taken at the characteristics of corporate growth. Once this is done, an examination of the higher education system will be undertaken. With this information, we can examine the economics profession and see if it responds in a way that would be in accordance with the data derived here and from corporate and higher education data. The growth of government indicates that the beginnings of paradigm shift in economics should take place beginning in the 1930s and consolidating in the 1940s.

Corporate Tax Receipts

This look at corporate tax receipts is sectioned off due to the interrelationship between government and corporations. The corporate entity has as the sate as the creator of its modern existence. The simple matter of limited liability is a state enforced creation. It is not the result of a contract, or other voluntary arrangement between private individuals. Dealings with a corporation, buying, selling, even entering corporate

[13] This is not to say either way that they *are* supplied in a scientific or an un-biased manner.
[14] Theoretically.

property, are voluntary arrangements. Limited liability regarding debts can also be voluntarily arranged. One factor, however, cannot be voluntarily contracted for and that is limited liability from damages to those who are not in contract with the corporation. Pollution is a simple example. If a factory pollutes and it harms those with whom the corporation has no contractual relations with, the corporation is limited in its liability for the costs of those damages. This benefit is a state creation. If one where to harm another with his car, his liability is not limited to the value, or investment in his car, but to his entire net wealth and possibly future wealth, the modern corporate owners are however, limited to their investment in the corporation in terms of liability.

The relationship between the state and the corporation that is examined here is corporate tax receipts by federal, state and local governments. This will give some indication as to the growth of the corporation and to the contribution its growth makes to government coffers. With this information, a look at the growth of the corporation and its contributions to government can be examined.

Table 5-7.

Taxes on Corporate Income 1929 to 1970

From: National Income and Product Accounts Table

Table 1.10. Gross Domestic Income by Type of Income

[Billions of dollars]

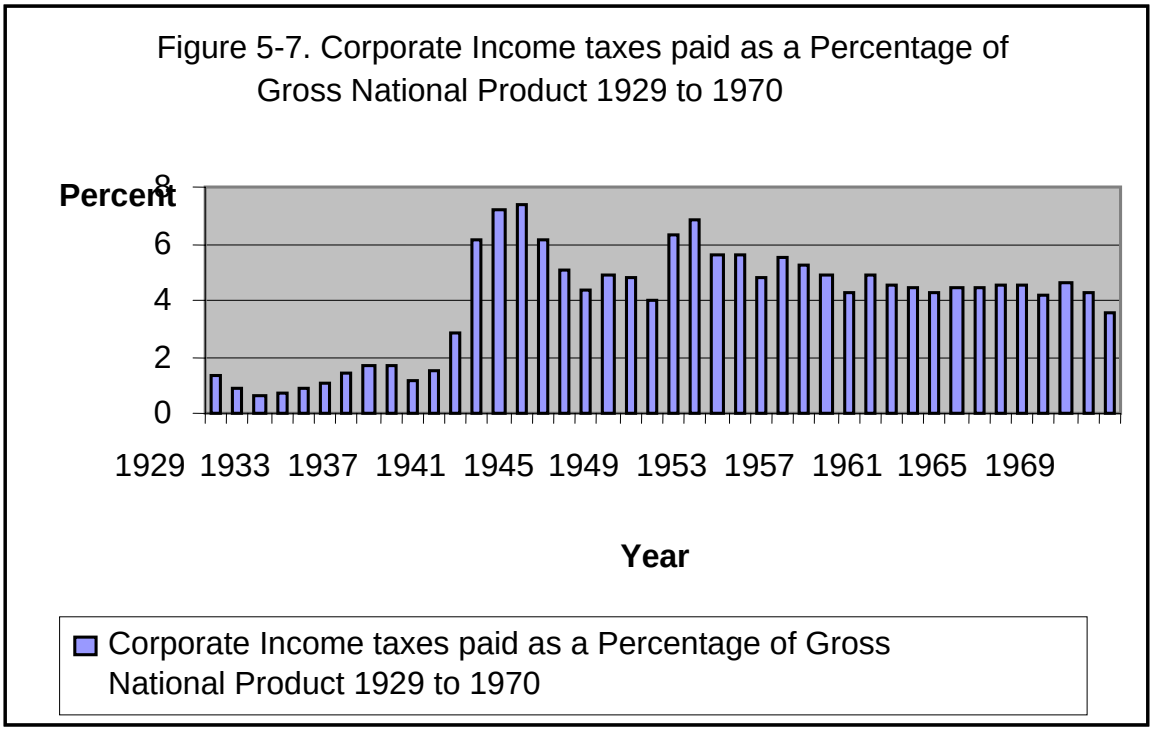
Source: http://www.bea.gov/bea/dn/nipaweb/TableView.asp#Mid

Year	Corporate Income Taxes*	Gross national Product*[15]	Percent GNP
1929	1.4	103.1	1.357905
1930	0.8	90.4	0.884956
1931	0.5	75.8	0.659631
1932	0.4	58	0.689655
1933	0.5	55.6	0.899281
1934	0.7	65.1	1.075269
1935	1	72.2	1.385042
1936	1.4	82.5	1.69697
1937	1.5	90.4	1.659292
1938	1	84.7	1.180638
1939	1.4	90.5	1.546961
1940	2.8	99.7	2.808425
1941	7.6	124.5	6.104418
1942	11.4	157.9	7.219759
1943	14.1	191.6	7.359081
1944	12.9	210.1	6.139933
1945	10.7	211.9	5.049552
1946	9.1	208.5	4.364508
1947	11.3	231.3	4.88543
1948	12.4	257.6	4.813665
1949	10.2	256.5	3.976608
1950	17.9	284.8	6.285112
1951	22.6	328.4	6.881851
1952	19.4	345.5	5.615051
1953	20.3	364.6	5.567745
1954	17.6	364.8	4.824561
1955	22	398	5.527638
1956	22	419.2	5.248092
1957	21.4	441.1	4.851508
1958	19	447.3	4.247708
1959	23.7	483.7	4.899731
1960	22.8	503.7	4.526504
1961	22.9	520.1	4.402999
1962	24.1	560.3	4.301267

[15] From Series F-1 of U.S. Bureau of the Census, *Historical statistics of the United States, Colonial Times to 1970* (Washington D.C.: US Government Printing Office, 1975). P. 224.

1963	26.4	590.5	4.470787
1964	28.2	632.4	4.459203
1965	31.1	684.9	4.540809
1966	33.9	749.9	4.520603
1967	32.9	793.9	4.144099
1968	39.6	864.2	4.582273
1969	40	930.3	4.299688
1970	34.8	977.1	3.56156

* In billions of current dollars



From the data above starting in 1929, 1.35% of GNP was paid as corporate income taxes. This percentage increases by 13.9% between 1929 and 1939, a 1.39% change averaged annually. Large-scale changes occur in the 1940s. Between 1939 and 1949, the percentage of GNP paid in corporate income taxes increases by 157.06%, an average annual rate of 15.71%. The yearly change in the 1940s on average is greater than the entire ten-year change during the 1929 to 1939 period. This demonstrates a rough estimate for the acceleration in corporate growth in the 1940s, rather than the 1930s as

was shown for government. This is not in any way contradictory to the implications laid out by theory earlier. Instead, it shows that government growth roughly predated corporate growth by a decade. This could also be in part due to events in the 1930s. During this time frame, we have the reduction in economic activity as a result of the Great Depression and during the early part of the 1940s World War II. This may have delayed the acceleration in corporate growth. In addition, the growth of the corporate from of business organization may have had as a causal factor the pre-existing growth of government.[16] The figures here also portray a large growth in revenues that governments receive as a result of corporate growth.

[16] See David O. Whitten, *The Emergence of Giant Enterprise, 1860-1914: American Commercial Enterprise and Extractive Industries* (Greenwood Ct: Greenwood Press, 1983). For a look at how government centralization and war can lead to the formation of large-scale commercial enterprises.

State and Local Government: Tax Receipts on Corporate Income

Table 5-8.

Title:	**State & Local Government: Tax Receipts on Corporate Income**
Series ID:	ASLCTA X
Source:	U.S. Department of Commerce: Bureau of Economic Analysis
Release:	Gross Domestic Product
Seasonal Adjustment:	Not Applicable
Frequency:	Annual
Units:	Billions of Dollars
Date Range:	1929-01-01 to 2004-01-01
Last Updated:	2005-12-05 1:50 PM CT
Notes:	A Guide to the National Income and Product Accounts Of the United States - (http://www.bea.doc.gov/bea/an/0398niw/maintext.htm)

DATE	State & Local Corp Inc Tax	Total Corp Income Tax[17]	GNP[18]	State and Local as percent of Corp Inc Tax[19]	State and Local as percent of GNP[20]
1929-01-01	0.1	1.4	103.1	7.14	0.10
1930-01-01	0.1	0.8	90.4	12.50	0.11
1931-01-01	0.1	0.5	75.8	20.00	0.13
1932-01-01	0.1	0.4	58	25.00	0.35
1933-01-01	0.1	0.5	55.6	20.00	0.18
1934-01-01	0.1	0.7	65.1	14.29	0.15
1935-01-01	0.1	1	72.2	10.00	0.14
1936-01-01	0.2	1.4	82.5	14.29	0.24
1937-01-01	0.2	1.5	90.4	13.33	0.22
1938-01-01	0.1	1	84.7	10.00	0.12
1939-01-01	0.2	1.4	90.5	14.29	0.22
1940-01-01	0.2	2.8	99.7	7.14	0.20
1941-01-01	0.3	7.6	124.5	3.95	0.24
1942-01-01	0.4	11.4	157.9	3.51	0.25
1943-01-01	0.5	14.1	191.6	3.55	0.26

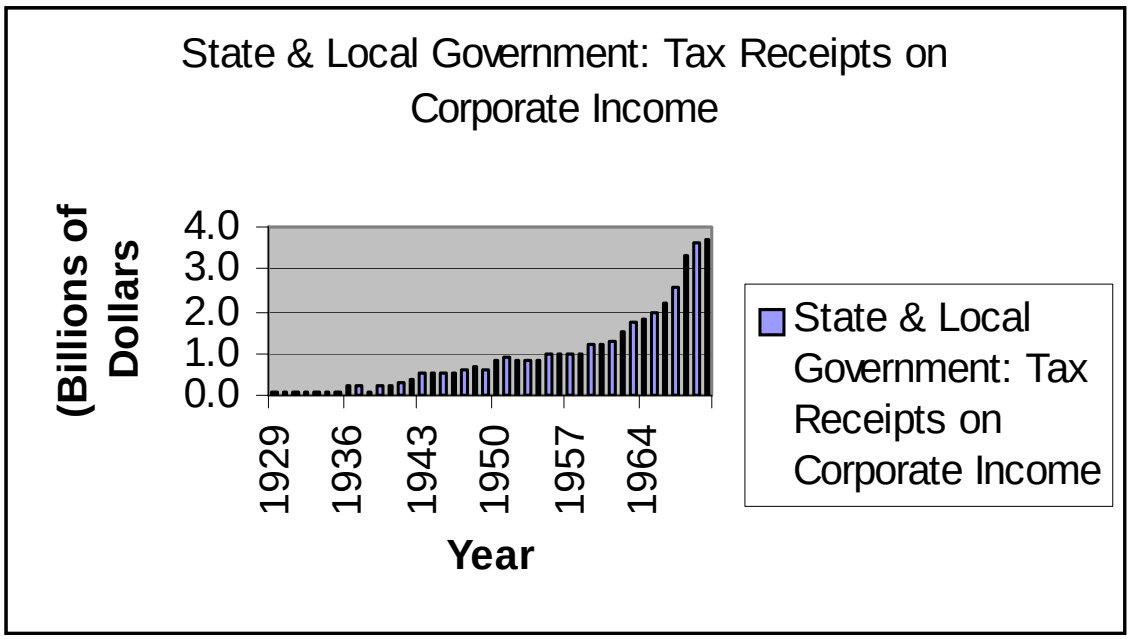
[17] From Table above
[18] From table Above
[19] Rounded to nearest 100th.
[20] Rounded to nearest 100th.

1944-01-01	0.5	12.9	210.1	3.88	0.24
1945-01-01	0.5	10.7	211.9	4.67	0.24
1946-01-01	0.5	9.1	208.5	5.49	0.24
1947-01-01	0.6	11.3	231.3	5.31	0.26
1948-01-01	0.7	12.4	257.6	5.65	0.27
1949-01-01	0.6	10.2	256.5	5.88	0.23
1950-01-01	0.8	17.9	284.8	4.47	0.28
1951-01-01	0.9	22.6	328.4	3.98	0.27
1952-01-01	0.8	19.4	345.5	4.12	0.23
1953-01-01	0.8	20.3	364.6	3.94	0.22
1954-01-01	0.8	17.6	364.8	4.55	0.22
1955-01-01	1.0	22	398	4.55	0.25
1956-01-01	1.0	22	419.2	4.55	0.24
1957-01-01	1.0	21.4	441.1	4.67	0.23
1958-01-01	1.0	19	447.3	5.26	0.22
1959-01-01	1.2	23.7	483.7	5.06	0.25
1960-01-01	1.2	22.8	503.7	5.26	0.24
1961-01-01	1.3	22.9	520.1	5.68	0.25
1962-01-01	1.5	24.1	560.3	6.22	0.27
1963-01-01	1.7	26.4	590.5	6.44	0.29
1964-01-01	1.8	28.2	632.4	6.38	0.28
1965-01-01	2.0	31.1	684.9	6.43	0.29
1966-01-01	2.2	33.9	749.9	6.49	0.29
1967-01-01	2.6	32.9	793.9	7.90	0.33
1968-01-01	3.3	39.6	864.2	8.33	0.38
1969-01-01	3.6	40	930.3	9.00	0.39
1970-01-01	3.7	34.8	977.1	10.63	0.38

It is shown above that over the past 41 years, corporate tax receipts for state and local governments has increase from .1 Billion to 3.7 billion in current dollars. What is important is the share of state and local corporate taxes as a percentage of total gross corporate income taxes and of GNP. This percentage was high during 1929and the 1930s due to low GNP figures and low total corporate income tax figures. The share of state and local corporate income taxes as a percentage of gross corporate income taxes has risen at a low rate of the period. This tends to indicate that the state and local governments have been increasing their share of corporate income relative to that of the federal government over the period. The state and local corporate income tax receipts have also increased

compared to GNP growth, this increase has been three fold over the period, but exhibits a relatively steady growth over the whole period.

Figure 5-8.



The information contained in the data for corporate income tax receipts shows that corporate taxes have increased over the period. The useful information is contained when we look at gross corporate income taxes as a percentage of GNP. We see that this data tends to support a view that corporate income tax payments accelerate in the 1940s. Thus, government revenues from corporate income taxes begin to take on added importance in the 1940s. This information lends to the idea that corporate growth begins to accelerate in the 1940s.

Government Growth: Implications

The evidence provided above tends to coincide with the theoretical implications from chapter 4. Government did grow and accelerate in its growth during the 1930s and 1940s. At the same time, while all governments grew, the federal government grew at a higher rate than state and local governments indicating a centralization of power to the federal government. This is supported by the data on federal, state and local consumption expenditures and gross investment during the 1900 to 1970 period. Also during this time, governments grew at a disproportionate rate to the private sector; this indicates that a growing portion of spending is done by governments versus the private sector. This indicates a shift of purchasing power from private individuals and the market towards government spending.

The percentage of the US workforce that is employed by government was also examined; the data supported the time frame involved in the implications of the theory. This indicates a growing proportion of resources being used in government production at the expense of private sector production. The information above indicates a reduction in the proportion of private production and spending at the expense of government spending and control of resources in the US economy. As such, there would tend to be an increase in the need for estimates of variable lost to government production and spending, resulting in a higher demand for predictions and estimates of these variables.

In all, the data supports the theory outlined and its implication that government growth can be related to the ascendance of mathematical methods in economics. This relation appears to occur in the 1930s and 1940s. During this period, the growth of

mathematical economics and government take place. According to the theory from chapter IV, this is no accident. Government growth increases the number of variable missing due to the absence prices from a freely functioning price system. As such, government policy makers and planners demand substitutes for these variables to manage and justify their policies and programs. Mathematical economics is the only competitor able to supply these substitutes under the mantle of science and objectivity.

Rise of the Large Corporation

The large corporation is a recent development. Incorporating involves certain positive effects with negative effects. On the positive side incorporation gives a firm limited liability. The owners of a corporation are limited in their liabilities n terms of debt and lawsuits arising from the use of corporate assets. The owner of a corporation's liability does not extend beyond the value of their investments. Only if the plaintiff can prove that the corporation was the alter ego of its owners can the owners be held personally liable.[21] Corporations also benefit through the pooling of assets made more attractive through limited liability. The greater pooling of assets also enables them to integrate various stages of production, and eliminate bargaining problems associated with a high number of shareholders, though not exclusively.

The benefits of incorporating also benefit owners in the event of a disagreement regarding the use of a firm's assets, and in the case that owners wish to disassociate themselves from the firm. If a co-owner in a partnership has reservation regarding the policies of a partnership he may decide to leave with his assets. This creates problems of uncertainty within the firm. The success of a partnership is based upon agreement by all

[21] Generally, the existence of more than one shareholder causes the probability of piercing the corporate veil (finding alter ego) to drop to virtually zero.

members of the partnership. Where there is dissent, the future of the firm is put in jeopardy by the threat that one individual may withdraw his assets. If the contract between the partners involves selling those assets as an option, then partnership assets are under a greater degree of uncertainty. Will the majority's policies be agreeable to a prospective partner with the ability to purchase the outgoing partner's stake?

This would tend to devalue the partnership. The corporation by decreasing the uncertainty associated with the eventual return on investment through the additional fact that partners may disagree and prevent completion of a project; this has an effect of the entrepreneurial component involved in the capitalist's interest rate. The natural rate of interest is based on time preference, an entrepreneurial component dealing with the uncertainty of repayment and a price premium.[22] In the event that partnerships can be dissolved over disagreements this would tend to increase the uncertainty of success and thus cause an increase in the entrepreneurial component of the interest rate. As such, all anticipated future earnings would be discounted more heavily.

> The market rate of interest on loans is not a pure interest rate. Among the components contributing to their determination there are also elements that are not interest. The moneylender is always an entrepreneur. Every grant of credit is a speculative entrepreneurial venture, the success or failure of which is uncertain . . .
>
> The entrepreneurial component included in the creditor's gross proceeds is determined by all those factors which are operative in every entrepreneurial venture.[23]

[23] Mises, p. 536-537.

On a free market, liabilities can be contracted and or insured. If, for example, a firm borrows money, it could in the loan contract set the limits of the owners' liability in the case of default. Any such agreement would of course increase the lender's uncertainty of repayment and thus result in a higher interest rate for the lender. The one case where government interventions create a situation outside the market is in the case of limiting liability incurred with a party not covered by contract. If a steel mill were to explode and harm an innocent bystander, who has no contract with the firm, liability would not be limited in a purely free market. The harmed individual would have the right to be compensated by those responsible for full damages in the absence of any limits. This creates a problem for the large corporate firm. As the firm expands the separation between management and operations from ownership widens. The uncertainty regarding the actions of employees and their use of a firm's assets grows as the separation between those employees and assets is increased through integration and growth of the firm.

In growing, firms may choose to integrate production processes. This integration, whether horizontal or vertical, has separate effects on the firm. On the one hand, by vertically integrating for instance, the firm may expect to receive benefits through the lowering of uncertainty in procuring the factors of production, or through ensuring demand for its own products by purchasing downstream demanders of their product. The negative effects can be a loss of efficiency through a weakening of economic calculation and/or a greater degree of separation between ownership and the control of the factors of production. The owners now must trust a greater number of people with their property, some of whom they do not even know.

In horizontally integrating the firm can take advantage of certain economies of scale involving certain specialized factors of production. These factors may be physical factors, technological, or based on other factors of production. A firm that has close ties to influential government officials and produces iron may be able to use this political capital in obtaining favorable protections for the production of some completely unrelated good. Firms grow to reduce costs, take advantages of the complimentary relationships between a pre-owned factor of production, used in one production process, and other complimentary factors in a different production process and to reduce uncertainty. The negatives to integration are, a reduction in the accuracy of economic calculation, specifically cost accounting, and potential increases in liability as the distance between ownership and control of the factors of production is widened. Regardless of the reason, limited liability is an enabler of firms to grow through integration.

The presence of limited liability decreases, in opposition to the market, the uncertainty associated with potential costs due to the harmful conduct of employees that harm individuals with whom the firm has no liability limiting contracts. This artificially increases the value of a corporate firm's assets versus partnerships, all other things being equal. The anticipated gains from limited liability result in a diminishing of the trade off value of partnerships versus corporate forms of organization and increase the possibility of calculation problems with in the firm.

If all the process in a production process were independent, each firm would complete one phase of production. They would have money prices for all of their input factors to use in computing the costs of the production process. They could evaluate different suppliers and chose the best among them in terms of cost and the quality of the input. The decision on the technological plan for production and what inputs to use are quantified by through the use of money prices. When firms vertically integrate they remove themselves from the money prices necessary to calculate costs. While this is clearly a negative effect, it can and often is outweighed in the minds of entrepreneurs by the reductions in other uncertainties, costs, or through the productivity gains related to the integration.

Limited liability, all other things being equal, skews this relationship. By limiting the liabilities incurred by firms due to damages caused to independent third parties, this increases the benefits of incorporating versus other forms of business organization, and to a corporation attaining a larger size through integration. In fact, the very implementation of limited liability by courts when damages are done to independent third parties results in the commission of an error. The third party is reduced to a lower state than he would have otherwise been in had limited liability not been enforced.

Internal to the firm, as a corporate entity increases in size and scope, the effectiveness of economic calculation is reduced. This reduction increases the uncertainty associated with anticipated future payoffs, or the accuracy of predictions regarding the relationship between costs and profits, both in the chosen production process and in relation to other possibilities (opportunity costs of the action). The value of intermediate products within the firm can only be valued in relation to their costs (a problem we see

with government goods and services), or, if a market consisting of other producers for those intermediate products exists, the value of similar products from other producers. This is already a distortion of the prices needed for true economic calculation. The nature of a good is time and place dependent. If a producer values, internally, an internal intermediate producers' good based on the value of competitors output, this price does not take in to account the demand placed on the product internally and ignores time and space considerations for the price of the good. In either case, the valuation placed on the good is less certainly correct, than if the whole stage of production that produces the good were carried on external to the downstream firm. In this case, the firm could determine the cost of the input through the use of a money price.

This problem results in difficulties determining if the internal production of the intermediate good is better than other options. This relates back to the ability to calculate and thus avoid errors. The level of judgment required through vertical integration is greatly increased. Couple this with the separation of ownership and management, and the problem of convincing superior managers in the firm and eventually the boards of directors and shareholders of the profitability of various production decisions become more difficult. As Peter G. Klein and Sandra Klein point out in their paper, "Do Entrepreneurs make predictable mistakes? Evidence from corporate divestitures," It cannot be shown ex-ante predictions are in fact mistakes.[24] The tool to such decisions is judgment, the owners of a large corporate firm are not fully informed of the conditions under which the decision is made and thus must rely on the advice of managers. As Klein and Klein also point out, changes in regulatory structures also inhibit economic

[24] Peter G. Klein and Sandra K. Klein, "Do Entrepreneurs make predictable mistakes?" Evidence from Corporate Divestitures," *The Quarterly Journal of Austrian Economics vol. 4, no. 2* (Summer, 2001).

calculation.[25] In the presence of regulatory change, certain actions previously allowed, are suddenly disallowed, or vice versa.

Mathematical economic provides a "mantel of science" to these predictions. There is a principle-agent problem in hiring an economist to perform studies to support or reject entrepreneurial decisions. [26] Prices missing in economic calculation due to the internalizing of various production processes and integration pose problems to large corporate firms. Mathematical economics supplies answers to these problems. Are they the correct answers, is a different question beyond the scope of this paper. Mathematical economics can provide estimates of numerical quantitative relationships between economic variables. Through the use of mathematical equations, generated, mathematical economists can provide estimates of non-existent prices that can be used to value goods that have no market prices. The validity of these estimates is not under question here, however, the principle-agent problem in estimating them is. Would it be in the interest of an economist working for a manager to provide estimates that differed from the judgments of his client? Where they do differ, which outcome is likely? The policy or production plans implied by the economist's work, or that derived from the judgment of the manager?

It would seem fallacious to view managers as deriving all of their decisions from the use of mathematical economics. If entrepreneurs and managers did, then we would expect to see the managers and entrepreneurs replaced by economists and statistical programs. The predictions and estimates of mathematical economics are a tool, rather

[25] Ibid., p. 17. Klein and Klein do point to empirical studies by other authors also.
[26] See, F. A Hayek, *The Counter-Revolution of Science: Studies on the Abuse of Reason* (Indianapolis, IN: Liberty Press, 1979). and Murray N. Rothbard, "The Mantle of Science," *The Logic of Action Vol. 1* (Cheltenham, UK: Edward Elgar Publishing limited, 1997). P. 3-23. for critiques.

than the guide of entrepreneurs and managers. They can be used as “objective” validations of what they already perceive to be the proper plans and production processes. By altering assumptions or techniques, the outcomes of mathematical economics can be altered. The right method is determined not scientifically, but subjectively. If one has the ability, the conclusion drawn from various analytic assumptions can be known in advance. The theory can be chosen to coincide with the desires of the demander. By manipulating arbitrary assumptions, models or statistical methods and data sets, the outcomes of economic analysis change. A selection problem exists, what economists, or models to use to answer a question can be determined by the desired outcome.

Despite the problems associated with corporations and estimates and predictions supplied by mathematical economics, there is no alternative when surveying non-mathematical paradigms. As such, the rise in corporate assets and revenues being concentrated in large vertically integrated firms would tend to increase demand for estimates and predictions of economics variables, and an increased demand for mathematical economists and models to produce these predictions.

The following section uses data to place a time frame for corporate growth. As will be shown, the data is inconclusive; however, the indications are that corporate growth tends to lag behind that of government by approximately a decade. This result is not contradictory to the implications laid out previously; rather it merely supports it. The growth of corporate activities does not predate the ascendance of mathematical economics, but come later. The growth of mathematical economics tends to begin at the same time as the accelerated growth, outlined in the growth of the state, of government in the United States in the 1930s and 1940s. The growth of corporate activities in the United

States may well have benefited from the dominance and increased resources available to practitioners of mathematical economics.

Data: Growth of the corporation

Corporate growth will be examined through several variables. A look will be taken at the percentage of net income reported by large and small corporations to examine concentration. Are corporate assets concentrated in large or small firms? The data indicates a concentration of net income in large corporations at the expense of small corporations. A large corporation is more likely to engage in vertical integration that a smaller corporation. This data will be used to gauge concentration of corporate activities to larger firms and be a proxy for vertical integration by corporate firms.

The number of corporate tax returns and the proportion of corporate tax returns to 1000 population will also be used. This data will tend to indicate the preference of corporate forms to other forms of business organization. It will also be useful determining when corporate activity increases in the United States.

Table 5-9.

Percent of total corporate net income reported by small and large corporations (with net income only), 1918-1939.

Year	Smallest	Next 20%	Largest 5%
1939	**3.40**	**12.11**	**84.49**
1938	**3.52**	**12.05**	**84.43**
1937	**3.07**	**11.58**	**85.35**
1936	**3.32**	**12.85**	**83.83**
1935	**3.90**	**14.73**	**81.37**
1934	**3.70**	**14.77**	**81.53**
1933	**3.08**	**13.1**	**83.82**

1932	**2.71**	**10.7**	**86.59**
1931	**4.46**	**10.78**	**84.76**
1930	**4.09**	**10.63**	**85.28**
1929	**3.97**	**11.69**	**84.34**
1928	**4.43**	**13.03**	**82.54**
1927	**4.66**	**14.63**	**80.71**
1926	**4.52**	**14.35**	**81.13**
1925	**4.97**	**15.44**	**79.59**
1924	**5.52**	**16.06**	**78.42**
1923	**5.28**	**16.44**	**78.28**
1922	**5.62**	**16.71**	**77.67**
1921	**6.34**	**16.06**	**77.6**
1920	**5.77**	**15.31**	**78.92**
1919	**7.01**	**16.26**	**76.73**
1918	**6.03**	**14.37**	**79.6**

The data above demonstrates a shift in net income from small corporations to large corporations over the time period 1918 to 1939. The change is a 6.14% increase in the proportion of corporate income earned by the largest 5% of corporations. As we have seen earlier, it appears that significant changes occur later on in the 1940s.

Finally, a look at corporate assets and receipts will be examined. This data will be put into real figures and used to time corporate growth. The data will tend to show an increase that accelerates in the 1940s and 1950s. The absolute increase in real corporate assets and revenues are not conclusive, however, due to the absence of data available on corporation during the 1900 to 1970 time frame it will be used since no substitute is available.

Corporate Tax Returns

The data in the table below will be used to calculate corporate tax returns per 100 population. This data shows that over the time period 1926 to 1927 the number of corporate tax returns per 1000 population increase substantially over the period. Data listed in the chart as corporate assets and corporate income after taxes are provided as a supplement. Corporate assets will be reused later in compiling real figures for that statistic.

Table 5-10.

Number of Corporate Tax Returns, Corporate Assets, and Income

1926 to 1970

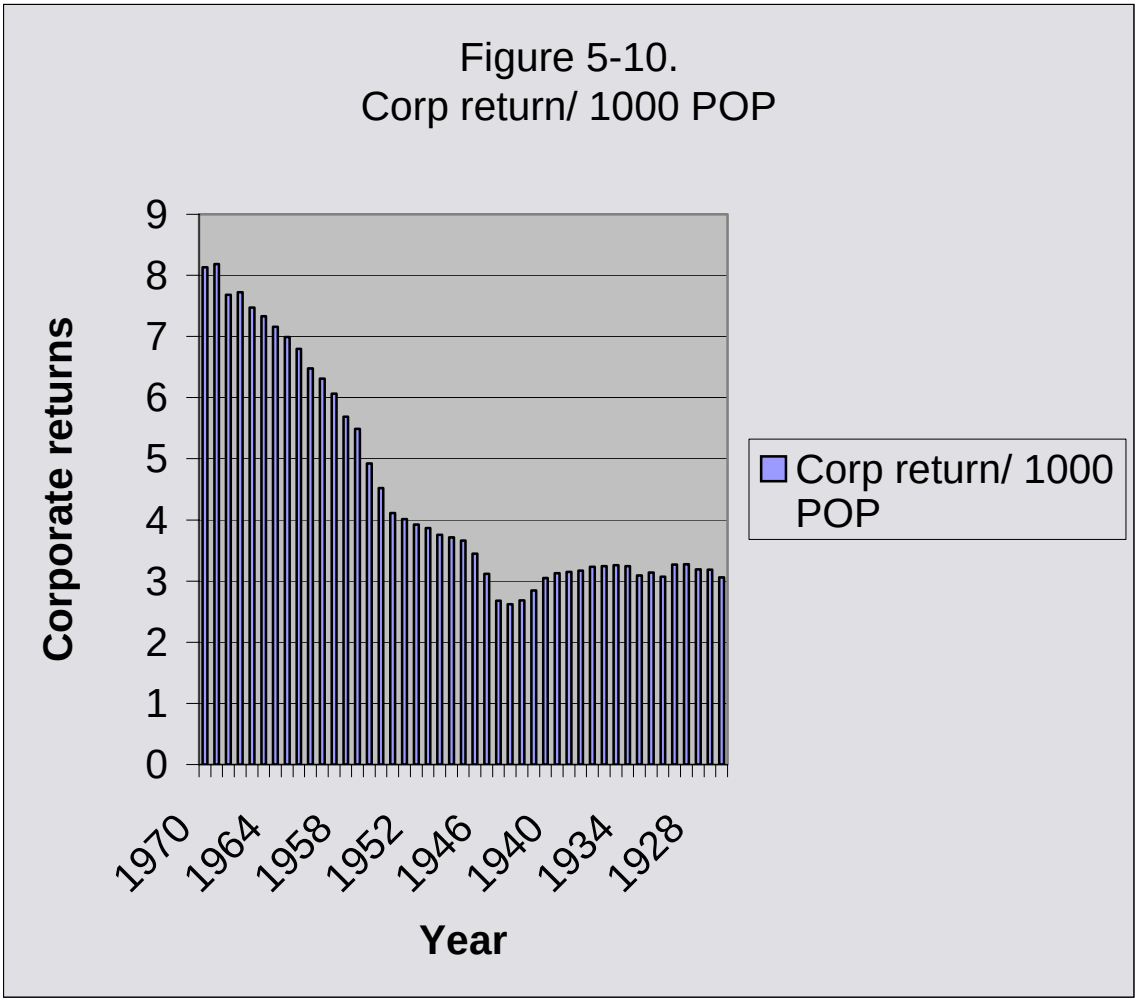
From Historical Statistics of the United States: Colonial Times to 1970 Series V108-140[27]

	(Number)	($Millions)	($Millions)	(thousands)	
Year	**Corporate Tax Returns**	**Corporate Assets**	**Corporate Income After Taxes**	**POP**	**Corp Return/ 1000 POP**
1970	1665477	2634707	34656	204879	8.129076186
1969	1658820	2445628	42761	202677	8.184549801
1968	1541670	2215625	47783	200706	7.68123524
1967	1534360	2010443	45949	198712	7.721526632
1966	1468725	1844775	46844	196560	7.47214591
1965	1423980	1723524	43079	194303	7.328656789
1964	1373517	1585619	35202	191889	7.15787252
1963	1323187	1481236	29438	189242	6.992036651
1962	1268042	1388127	26912	186538	6.797767747
1961	1190286	1289516	24846	183691	6.479827536
1960	1140574	1206662	22633	180671	6.312988803
1959	1074120	1136688	25130	177073	6.065972791
1958	990381	1064481	20410	174141	5.687236205
1957	940147	996400	24491	171274	5.489140208
1956	827916	948951	25962	168221	4.921597185
1955	746962	888621	26065	165275	4.519509908
1954	667856	805300	19804	162391	4.11264171

[27] From U.S. Bureau of the Census, *Historical statistics of the United States, Colonial Times to 1970* (Washington D.C.: US Government Printing Office, 1975). P. 924-26.

1953	640073	761877	19889	159565	4.011362141
1952	615698	721864	19504	156954	3.922792665
1951	596385	647524	21593	154287	3.865426121
1950	569961	598369	25968	151684	3.757555181
1949	554573	543562	18422	149188	3.717276188
1948	536833	525136	22477	146631	3.661115317
1947	496821	494615	20420	144126	3.447129595
1946	440750	454705	16314	141389	3.117286352
1945	374950	441461	10518	139928	2.679592362
1944	363056	418324	11685	138397	2.623293858
1943	366870	389524	12181	136739	2.68299461
1942	383534	360018	11141	134860	2.843941866
1941	407053	340452	9528	133402	3.051326067
1940	413716	320478	6947	132122	3.131318024
1939	412759	306801	6019	131028	3.150158745
1938	411941	300022	3300	129969	3.169532735
1937	416902	303357	6531	128961	3.2327758
1936	415654	303180	6473	128181	3.242711478
1935	415205	303150	4778	127362	3.260038316
1934	410626	301307	2451	126485	3.246440289
1933	388564	268206*1056 (8)*		125690	3.091447211
1932	392021	280083*3792 (8)*		124949	3.137448079
1931	381088	296497*880*		124149	3.069601849
1930	403173	334002*N/A*		123188	3.272826899
1929	398815	335778*N/A*		121767	3.275230563
1928	384548	307218*N/A*		120509	3.191031375
1927	379156	287542*N/A*		119035	3.185248036
1926	359449	262179*N/A*		117397	3.061824408

The Number of Corporate Returns per 1000 population (incl. Armed Services) and Real Corporate Assets in 1996 Dollars (Corporate Assets/(Implicit GDP Price Deflator/100))
Data: Historical Statistical Abstract of the United States, Colonial Times to 1970 and Bureau of Economic Research web page "Implicit Price Deflator" http://www.bea.gov/bea/dn/nipaweb/TableView



The data and chart above indicate a significant increase in the number of corporate tax returns filed per 1000 population occurring in the 1940. This event appears to begin around 1944 and take full steam later in the decade. The data from corporate returns per 1000 population also supports an increase in corporate activity occurring in the 1940s and lagging that of government growth.

Corporate Total Assets and Corporate Receipts

Corporate total assets and corporate receipts are used to compile real figures to time the rise of corporate activities in the US. The data was obtained from the *Historical statistics of the United States, Colonial Times to 1970*.

Table 5-11.
Series V 109, and V. 129
From Corporate Asset, Liability, Income, Deduction, Tax and Profit Items, and Dividends Paid for All Industries: 1926 to 1970.
In Millions of Dollars.
Source: U.S. Bureau of the Census, Historical statistics of the United States,
Colonial Times to 1970 (Washington D.C.: US Government Printing Office, 1975).
P. 924-926.

Year	Corporate Total Assets	Corporate Receipts	Implicit Price Deflator For GNP
1926	262179		51.1
1927	287542		50
1928	307218		50.8
1929	335778		50.6
1930	334002		49.3
1931	296497	105238	44.8
1932	280083	79701	40.2
1933	268206	82148	39.3
1934	301307	99905	42.2
1935	303150	112098	42.6
1936	303180	126269	42.7
1937	303357	138907	44.5
1938	300022	117596	43.9
1939	306801	130365	43.2
1940	320478	145427	43.9
1941	340452	186137	47.2
1942	360018	213777	53
1943	389524	245796	56.8
1944	418324	258880	48.2
1945	441461	252636	59.7
1946	454705	283917	66.7
1947	494615	361521	74.6

1948	525136	405430	79.6
1949	543562	387636	79.1
1950	598369	452523	80.2
1951	647524	511849	85.6
1952	721864	525011	87.5
1953	761877	551984	88.3
1954	805300	547001	89.6
1955	888621	634508	90.9
1956	948951	673493	94
1957	996400	720414	97.5
1958	1064481	735338	100
1959	1136668	816800	101.6
1960	1206662	849132	103.3
1961	1289516	873178	104.6
1962	1388127	949305	105.8
1963	1481236	1008743	106.1
1964	1585619	1086739	107.4
1965	1723524	1194601	108.8
1966	1844775	1306518	113.9
1967	2010443	1374599	117.6
1968	2215625	1507786	122.3
1969	2445628	1680482	128.2
1970	2634707	1750728	135.2

The data in this table is in nominal figures. This data is used in the next table to come up with real figures for corporate total assets and corporate receipts. The growth of corporate institutions can then be evaluated.

Real Corporate Total Assets and Real Corporate Receipts 1931 to 1970

The real corporate total asset statistic was compiled using the data in the table above. This information will give an indication to the timing of the growth in corporate activity within the United States between 1926 and 1970. The chart for this data will be presented along with the chart for real corporate receipts during the period 1931 to 1970 for comparison purposes, at the end of the data table for real corporate receipts.

Table 5-12.
Real Corporate Total Assets 1926 to 1970
Source: Data from Corporate Asset, Liability, Income, Deduction, Tax and Profit Items and Dividends Paid for All Industries: 1926 to 1970.

Year	Real Corporate Total Assets
1926	513070.45
1927	575084.00
1928	604759.84
1929	663592.89
1930	677488.84
1931	661823.66
1932	696723.88
1933	682458.02
1934	713997.63
1935	711619.72
1936	710023.42
1937	681701.12
1938	683421.41
1939	710187.50
1940	730018.22
1941	721296.61
1942	679279.25
1943	685781.69
1944	867892.12
1945	739465.66
1946	681716.64
1947	663022.79
1948	659718.59
1949	687183.31
1950	746096.01
1951	756453.27
1952	824987.43
1953	862827.86
1954	898772.32
1955	977580.86
1956	1009522.34
1957	1021948.72
1958	1064481.00
1959	1118767.72

1960	1168114.23
1961	1232806.88
1962	1312029.30
1963	1396075.40
1964	1476367.78
1965	1584121.32
1966	1619644.42
1967	1709560.37
1968	1811631.23
1969	1907666.15
1970	1948747.78

Table 5-13.
Real Corporate Receipts 1931 to 1970
Source: Data from Corporate Asset, Liability, Income, Deduction, Tax and Profit
Items and Dividends Paid for All Industries: 1926 to 1970.

Year	Real Corporate Receipts
1931	234906
1932	198261
1933	209028
1934	236742
1935	263141
1936	295712
1937	312151
1938	267872
1939	301771
1940	331269
1941	394358
1942	403353
1943	432739
1944	537095
1945	423176
1946	425663
1947	484613
1948	509334
1949	490058
1950	564243
1951	597954
1952	600013
1953	625123
1954	610492

1955	698029
1956	716482
1957	738886
1958	735338
1959	803937
1960	822006
1961	834778
1962	897264
1963	950747
1964	1011861
1965	1097979
1966	1147075
1967	1168877
1968	1232859
1969	1310828
1970	1294917

The data from the corporate real assets and corporate real receipts can be examined in a graph that is provided below. The charts lend some usefulness by examining the growth of real corporate assets and receipts over time. This growth and its timing will be further evidence of the rise of corporate forms of business management. This combined with a demonstrated concentration of corporate activity towards larger firms give evidence that corporate growth in the US has occurred over a period corresponding to the 1940s and 1950s.

Corporate growth: Implications

Data from the tables and charts above indicate a period of growth for the corporation beginning in the 1940s and 1950s as a beginning. This data is in accordance with the theory and implications put forward earlier. The only issue is, notwithstanding the lack of data, the exact timing of this rise and whether the Great Depression and Second World War of the 1930s and 1940s stifled it, which seems extremely plausible. Alternatively, was the growth of the state a necessary precondition for an acceleration of

corporate growth? Either idea is plausible, but neither contradicts theory. While it is asserted that corporate growth is an element of the growth of mathematical economics, it is not necessary. It could very well be that the growth of the state and mathematical economic methods created an environment that fostered increased corporate growth. Once corporate growth took place, it would increase demand for mathematical economics above that already demanded by the increasing state.

Figure 5-11.

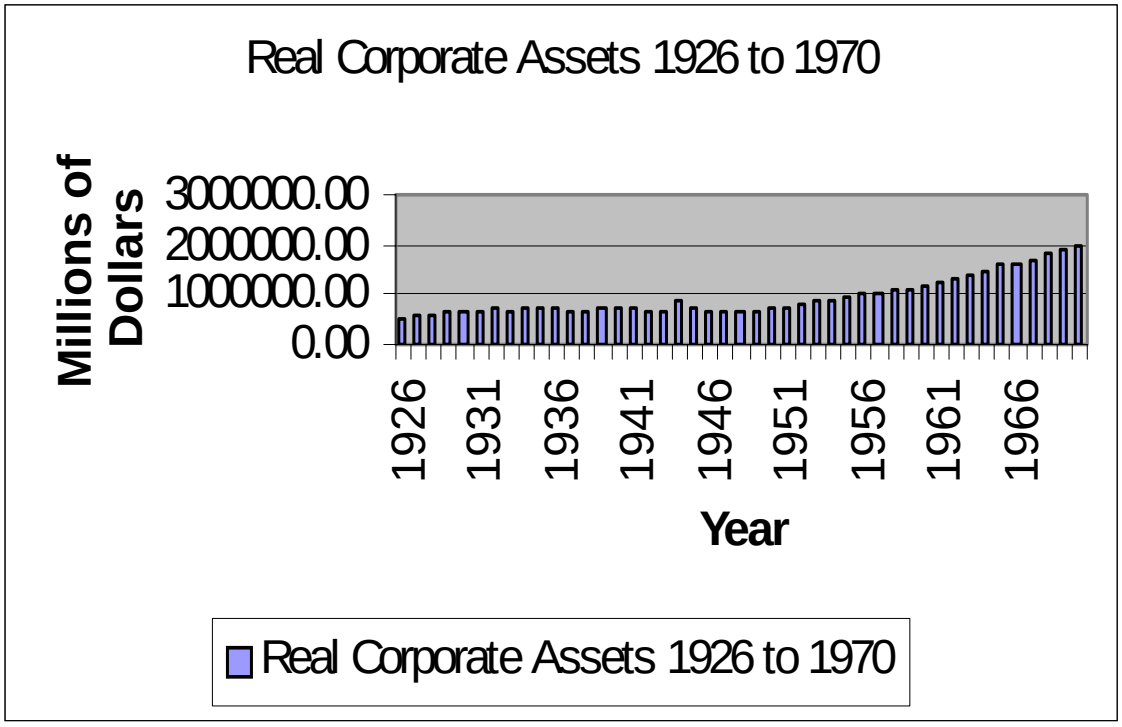
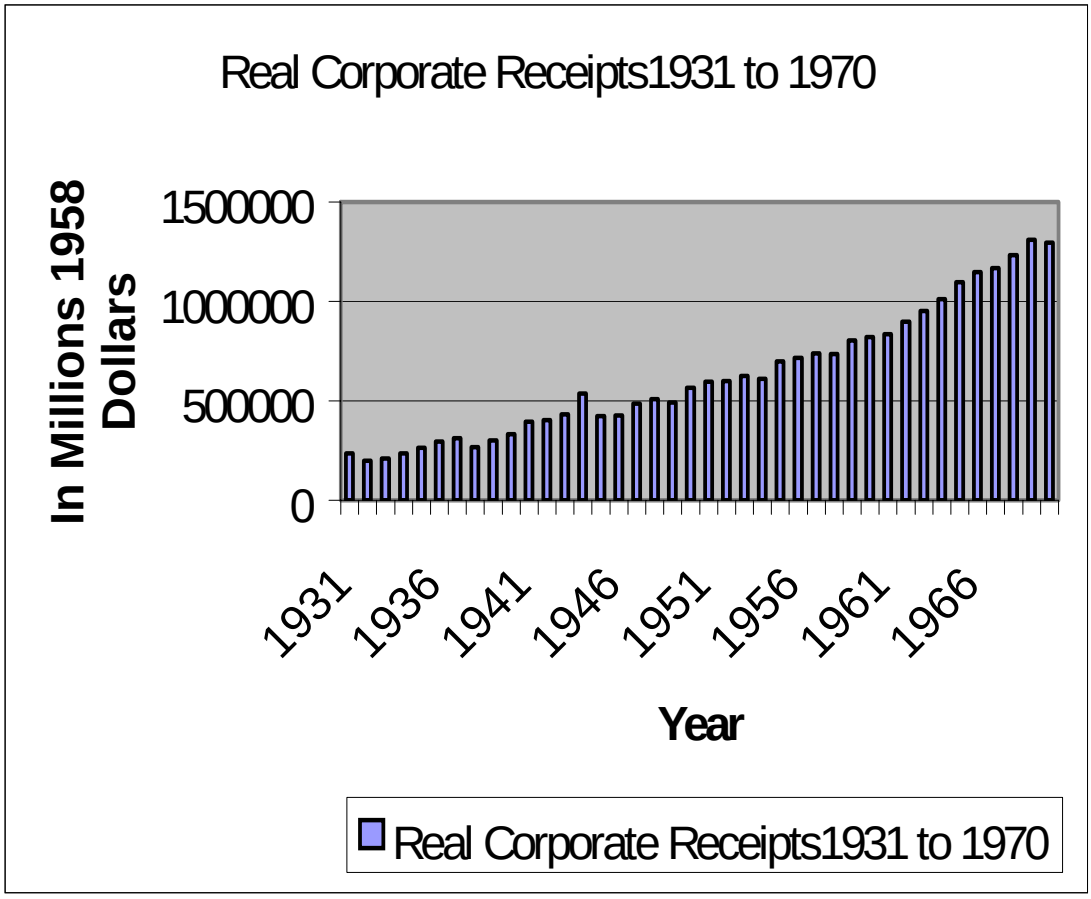


Figure 5-12.



In the section on corporate growth, the indication is that corporate activity both increased and consolidated into larger firms over the period 1929 to 1970. This concentration of assets under the control of corporate control leads to the conclusion that there has been some separation in the period between ownership and management. As a result, there is a need for predictions of future values for economic variables such as price and interest rates. These predictions can be handled without objection by judgment in a smaller firm; larger firms with diverse ownership and control must come to common ground regarding conflicting beliefs regarding future variables. As such, mathematical

economics plays a role in producing prediction under the mantle of science. This is not to say that economic predictions rule the day. If that were the case, then entrepreneurs could simply model the economy, sit back and let predictions from economic models determine their decisions. The mantle of science adds validity to those who agree with the economist's predictions and adds uncertainty to predictions that contradict those found using mathematical economic methods.

Higher Education

In the preceding sections of chapter V, the growth of government and the corporation have been examined. The rise of government has as a beginning been set in the 1930s and progressing through the 1940s. This growth precedes the beginning of corporate growth in 1940s and 1950s. This growth, in accordance with the theory laid out earlier, creates an increased demand for theories and scientific research that deals with the problems and issues of state and corporate planners and managers. While not all research is designed to solve or address these issues, the demand for theories that can solve problems specific to government and corporate issues that arise due to the natures of these institutions increases relative to theories and research that do not address issues specific to government and corporate institutions. As a result, we expect to see increased interest on the part of governments and corporate institutions in funding research that serves the ends of these institutions.

The intent of this dissertation is not to address the effects of state and corporate growth on all fields of research, but rather to examine its effect on one specific field, economics. To examine the field of economics, we must also examine the effects of the growth of government and corporate institutions on higher education as a whole.

In addition, the data from higher education will serve as a proxy for similar variables in the economics profession, due to a lack of data concerning the funding of economic research and departments. We can gather from the data on higher education that if federal funding for higher education increases both in proportion and in absolute terms, that some of this new money must find its way into economics departments. Thus if the size and proportion of higher education funding from government sources is altered, it would be reasonable to conclude, in the absence of additional data regarding economics departments and research institutions, that this same alteration is occurring within their budgets.

The bulk of the data concerning higher education sources for funding comes from the *Historical Statistics of the United States: Colonial Times to 1970, Bicentennial Edition*. The data will disclose the increased funding that governments have showered onto higher education institutions since the 1930s. It will also examine the changing nature of where funds for higher education come from. We will examine the make-up of higher education budgets between private funding, (fees, endowment earnings, and private gifts), and public funding (student aid, state and local and federal funds). Has the proportion of private and public funds been altered over the 1900-1970 period, if so, in which direction, and when did this occur? A further examination will be undertaken to examine whether there has been a change in the number of higher education professional (college presidents, professors, and instructors) over the period. An increase in government and corporate institutions, with growing proportions of income, would have an effect of increasing the role of higher education in the United States due to increased funding of higher education.

The data

In order to examine the absolute values of federal, state and local funding for education, the current income of higher education institutions will be examined. This data will establish where the funds for higher educational institutions came from for the period 1890 to 1970. The growth of government funding for higher education will be examined. The data will also be used to examine the proportions of funding that come from public and private sources. Was there a shift of funding from private to public sources over the period, and when did it occur.

An examination of the number of academic professional will also be undertaken. With this data, an examination of the growth of academic professions can be performed, and more importantly the growth of the academic profession relative to over all population. Increased funding and a shifting of resources to academic pursuits from other areas of the economy would indicate that the increases in funding, whatever the source, are a source of growth in academics. The sources of this additional funding would then be in a position to demand solutions to their problems, some specific to their nature, at the expense of other demanders of higher education. The structure of the institutions of higher learning would then be expected to be altered to take advantage of the new funding sources and comply with the demands of government planners and policy makers. This would be a competitive process. Those who best met the needs of the increasing state would be rewarded at the expense of those who did not. This would be felt by higher education institutions, and departments, and thus by academic professions as well.

A Short History of US Higher Education

Throughout American history, there have been attempts by the federal government to be come active in higher education. During the debates leading to the US Constitution, there was a movement to set up a national university. "In January, 1787, the Philadelphia physician and man of affairs Benjamin Rush published an article in which he called upon the nation to establish a postgraduate university at its capital city. . ." "At the Constitutional Convention in 1787, some delegates proposed that a definite clause be included in the document, enabling the United States Congress to establish a national university." [28]

Many different movements took place over the 1700s and 1800s. George Washington himself left shares of stock to the US government to be used to build a national University.[29] Very little was done by the federal government to control university educations during the 1800s, assistance was usually in the form of grants, mostly land. Beginning in 1787, a university grant was made to the Ohio and Scioto Company. This activity was continued in 1802 with the passage of the Ohio Enabling Act. The act allowed the federal government to parcel out townships to give to states for the purposes of higher education. In all, 31 state received land under this act.[30] According to Brubacher and Rudy, "no attempt was made by the federal government to control the type of education that was to be given.

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[28] John S. Brubacher and Willis Rudy, *Higher Education in Transition: A History of American Colleges and Universities, 1636-1976, 3rd edition*, (New York: Harper and Row Publishers, 1976) p. 220.
[29] Ibid., p. 220. Legislators, who debated over the constitutionality of a national university, ignored Washington's bequest. The gift left by Washington was 50 shares of stock in the Potomac River Company. The point became mute when the Potomac River Company shares became worthless in 1828.
[30] Ibid., p. 227. According to Brubacher and Willis, eastern States such as Maryland opposed the act with the admission of every new state. The grants were given to new western states upon their entry into the union.

In 1862, the Morrill Act was passed utilizing federal assistance to higher education institutions, as "a means of stimulating special types of education within states."[31] In 1890, a second Morrill act was passed; this act stated that annual federal funds could be withheld from any state that failed to meet standards set by federal law.[32] The Second Morrill act also limited the fields of study permissible at state land grant institutions. The previous Morrill act said institutions should have agricultural and mechanical programs, but that that this should not be at the exclusion of scientific and classical studies. The Second Morrill Act" enumerated more specifically, and more narrowly, the subject-matter fields for which the annual appropriations could be used."[33] "By 1917, The Hatch act 0f 1887, the Smith-Lever Act of 1914, and the Smith-Hughes Act, of 1917 created a means of federal subsidies of higher education that totaled $23,000,000 a year by 1930. In was not until 1930 that the federal government began to distribute funds directly to private institutions in times of peace.[34]

The first federal program to assist individual students in funding higher education expenses was the National Youth Administration (1935 to1943). [35] During this period, the federal government spent $93,000,000 on 620,000 students. Following the World War II, we see the beginning of the G.I. Bill which combined with its counterpart for the Korean Conflict, constitutes the "largest scholarship grant to that point in the history of

[31] Ibid., p. 228.
[32] Ibid., p. 229. In addition, the Adams act of 1906 began to limit and demand certain subjects of study for agricultural research grants, and granted greater supervisory power over the grants to the Secretary of Agriculture.
[33] Ibid., p. 229.
[34] Ibid., p. 230. Prior to the 1930s federal funds were disbursed to private institutions during times of war for Military training.
[35] Ibid., p. 230.

American higher education.[36] In 1944 the "G.I. Bill" officially known as the Servicemen's Readjustment Act of 1944, was passed. Under the bill, payment was 'officially' given to students, who then paid it to the universities and colleges.[37] This act was augmented after the Korean War by Public Law 550 of 1952.

In the instances above we have governments subsidizing universities and colleges both directly through grants and funding, including the construction of buildings and equipment (beginning in the 1940s with the Surplus Property Act of 1944 with the donation and discounted pricing of old military equipment, and continuing in 1950 when congress passed a bill authorizing the Housing and Home Finance Agency to make up to $300,000,000 in long-term loans to colleges and Universities to erect dormitories). By 1962, over $2 Billion had been loaned to universities for dormitories and other revenue producing facilities.[38]

On the one hand, governments at all levels were subsidizing the production of universities and colleges with grants, low interest loans and other subsidies, to increase the supply of higher education, while on the other hand subsidizing the purchase of such services through student aid and low interest loans. In addition, throughout the period under consideration, the federal government has paid for the tuition of government employees and active duty servicemen. The expansion of higher education has been subsidized at both the demand and the supply side since the 1930s and 1940s.

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[36] John S. Brubacher and Willis Rudy, *Higher Education in Transition: A History of American Colleges and Universities, 1636-1976, 3rd edition*, (New York: Harper and Row Publishers, 1976) p. 230-31.
[37] Ibid., p. 230.
[38] Ibid., p. 232-33.

Federal funding of research "began to increase during 1917 and 1918."[39] ". . . the impact of the Second World War led Washington to assume 83 percent of the nation's total research budget. This demonstrates the control that was exerted in scientific fields by governments during the 1940s. Demand for scientific research in fields that were of concern for government planners, politicians, and managers were highly subsidized. According to Brubacher and Rudy, in referring to research funding into the 1950s, "Here again we have an example, not of a general and permanent federal policy, but of a special program motivated by government's vital interest in national defense."[40]

Statistics

The history of higher education provides a framework through which to view the data presented. Funding for higher education by federal, state and local governments will be examined. The share of total higher education income derived by government sources will be examined. A sharp increase in the proportion of government funds at the expense of non-government funds will be examined to discover the timing and the influence that governments have on higher education budgets. The history of higher education provided by Brubacher and Rudy fits well with the data that will be presented.

The number of college presidents, professors, and instructors per 1000 population will also be examined. This statistic will be used as a proxy for the shift of resources from non-higher education sectors into the higher education sector. This statistic will also be useful in examining the timing of the rise of higher education relative to the rest of the economy. The theory put forward earlier would implicate a rise in the size and scope of

[39] John S. Brubacher and Willis Rudy, *Higher Education in Transition: A History of American Colleges and Universities, 1636-1976, 3rd edition*, (New York: Harper and Row Publishers, 1976) p. 231.
[40]Ibid., p. 231. Brubacher and Rudy are referring to federal programs that supplied 83% of the nation's total research budget in the natural sciences. "By 1950, a dozen or more federal agencies were spending over 150,000,000 a year in contract research. . . "

higher education relative to the rest of the economy, and this timing to coincide with the rise of the states. As such, the demands of government planners and policy makers would be expected to increase in their relative importance to other demands placed on the higher education system.

Higher Education –Current Income

Below is reported higher education income for the period 1890-1970. Data prior to 1920 is incomplete, but it will be useful in timing increases to higher education institution's budgets as a result of government funding. Over the period, there is a dramatic increase in the amount and proportion of higher education current income that comes as a result of government funding.

Table 5-14.
Higher Education
Institutions of Higher Education --Current Income
1890-1970 **All amounts in Millions of US Dollars (unadjusted)**

Year	Total Income High Ed	Total Income High Ed from Ed &Gen Inc	Student Fees	Endowment Earnings
1970	21515	16486	4420	447
1969	18875	14330	3814	413
1968	16825	13846	3380	364
1966	12734	10285	2641	289
1964	9544	7788	1893	266
1962	7429	6040	1500	232
1960*	5786	4688	1157	207
1958	4641	3733	934	182
1956	3603	2859	722	145
1954	2946	2339	551	127
1952	2562	2021	447	113
1950	2375	1834	395	96
1948	2027	1538	305	87
1946	1169	925	214	90
1944	1047	864	154	75

1942	784	626	201	74
1940	715	571	201	71
1938	653	522	179	71
1936	598	491	158	60
1934	486	289	138	56
1932	566	452	151	61
1930	555	483	144	69
1920	200	173	42	26
1910	77	68		
1900		35		
1890		21		

(1) Includes local funds	(2) Includes Local and Federal Funds
(3) Includes "Major Public Service," previously included in " Educational and General Income" items, series H 717-725	(4) Student aid income only
(5) Universities, Colleges, and professional schools only, teachers colleges and normal schools omitted	(6) May include Federal Funds for teachers colleges and normal schools

Table 5-14. (Cont)

Education and General Income For Higher Education

Year	Federal Funds	State Funds	Local Gov Fund	Gifts and Grants	Organized Activities related(7)	Other Sources	Student Aid and other current income
1970	2682	5788	775	1001	613	760(3)	2129
1969	2505	4812	614	916	549	706(3)	1854
1968	3348	4181	504	848	808	411(4)	498
1966	2588	2895	303	614	624	332(4)	310
1964	2161	2111	240	551	428	139(4)	148
1962	1538	1668	191	450	356	105(4)	118
1960*	1037	1374	152	383	290	88(4)	93
1958	707	1138	129	324	246	71(4)	70
1956	490	878	107	245	192	80(4)	52
1954	417	740	88	191	165	59(4)	32
1952	451	611	72	150	136	41(4)	32
1950	524	492	61	119	112	35	30
1948	526	352	48	91	93	36	24
1946	197	225	31	78	67	23N/A	
1944	308	175	26	50	54	20N/A	
1942	58	167	27	46	40	13N/A	
1940	39	151	24	40	33	11N/A	

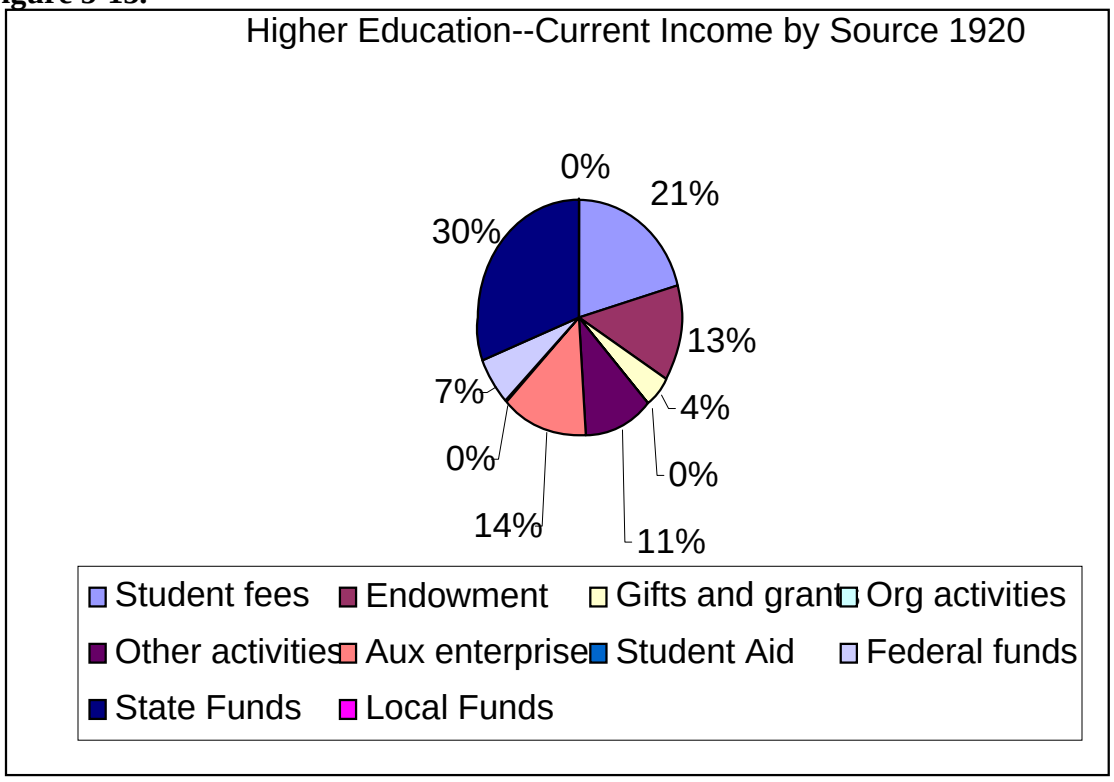
1938	**29**	**141**	**22**	**37**	**28**	**15**N/A	
1936	**43**	**120**	**21**	**37**	**25**	**27**N/A	
1934	**20118 (1) Inc w/ state**			**27**	**18**	**12**	**10**
1932	**175 (2) Inc w/ state**			**30**	**21**	**15**	**11**
1930	**21151 (1) Inc w/ state**			**26**		**73**	**11**
1920	**1362 (1)(7) Inc w/ state**			**8**		**22**	
1910							
1900							
1890							

(1) Includes local funds	(2) Includes Local and Federal Funds
(3) Includes "Major Public Service," previously included in " Educational and General Income" items, series H 717-725	(4) Student aid income only
(5) Universities, Colleges, and professional schools only, teachers colleges and normal schools omitted	(6) May include Federal Funds for teachers colleges and normal schools

The data above indicates rise in the quantity of funds given to higher education over the period. In 1920, $75 million dollars, or roughly 37.5% of higher education current income came from governments (federal, State, and local), this is shown in the pie chart below. By 1970, $6.24 Billion dollars or, 52.8% of higher education current income was the result of government funding and student aid. None of this takes into account government land, equipment, building or other infrastructure grants and loans. The degree of government subsidies to higher education has increased significantly over the 1920 -1970 period.

The following charts will present the shift in higher education income that increased government funding caused in the make up of higher education income. In 1920, less than 30% of all higher education income was the result of government funding and student aid, by 1970 there is a dramatic shift as 64.6% of all current income is the result of government funding.

Figure 5-13.



The chart above shows a breakdown of sources for higher education funding in 920. The section of the chart that contains federal, state, and local funds, along with student aid funding incorporates 37.5% of all higher education—current income. This can be contrasted with the following years of 1930, 1934, 1940, and 1949.

Figure 5-14.

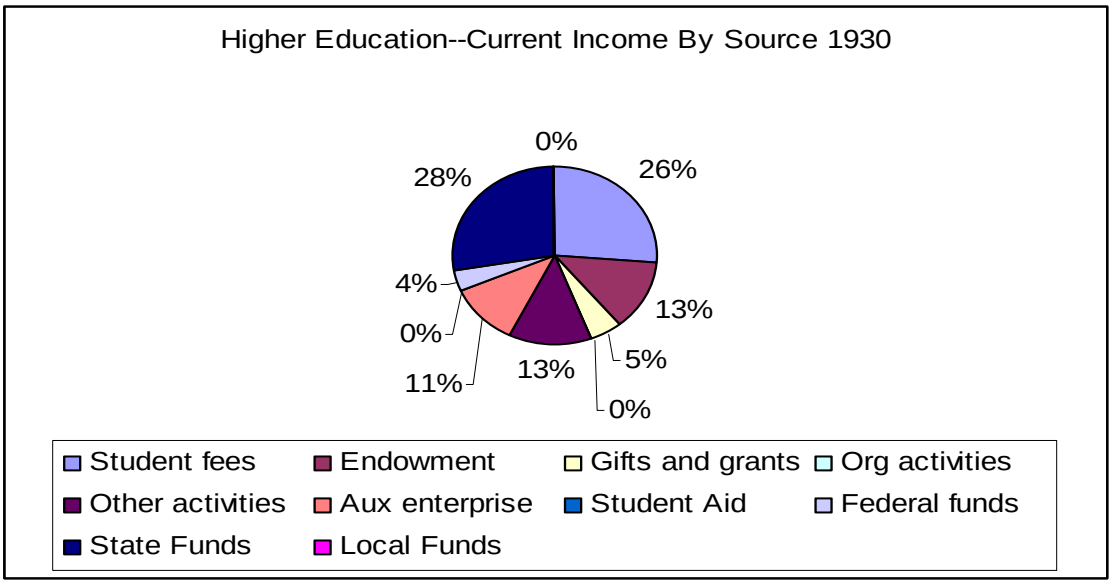


Figure 5-15.

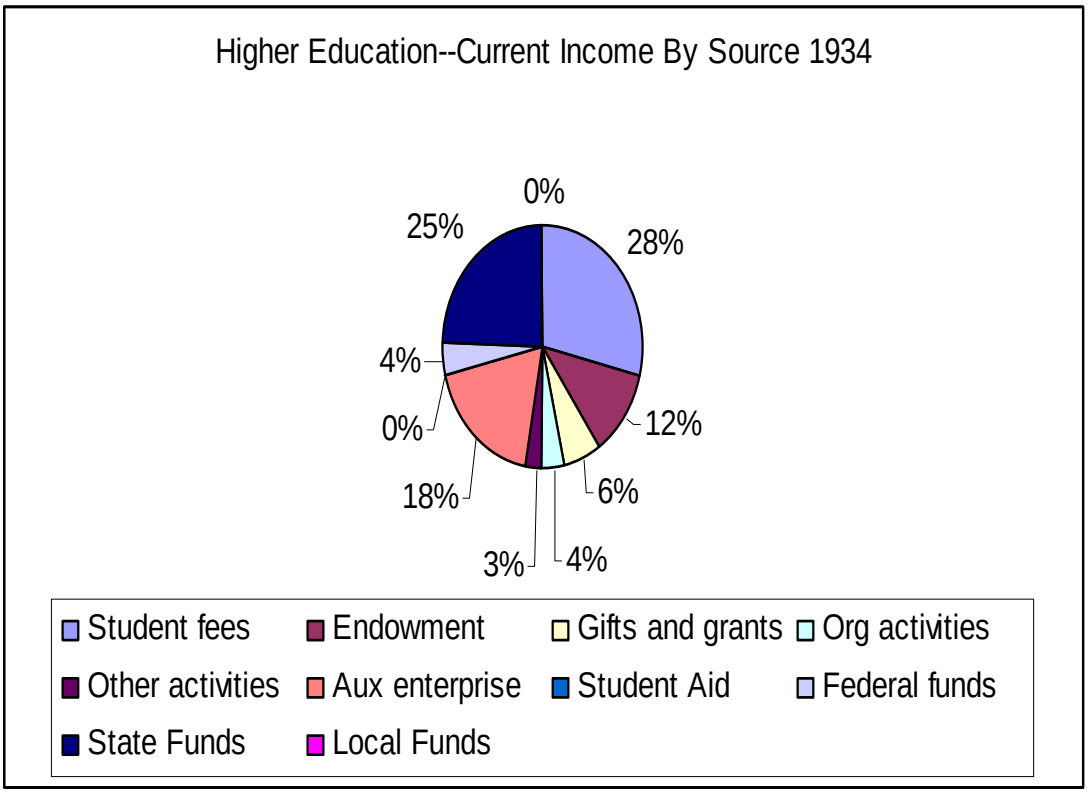


Figure 5-16

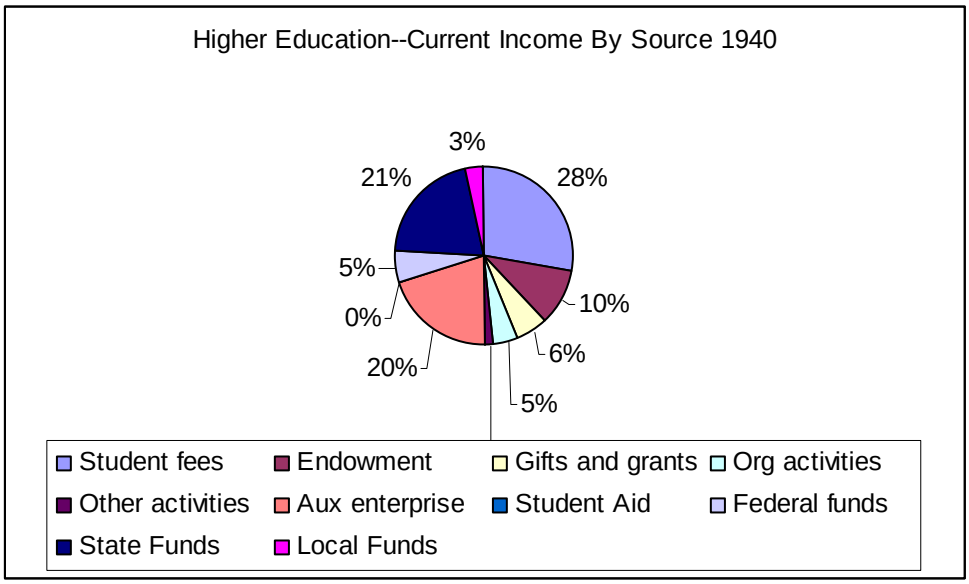
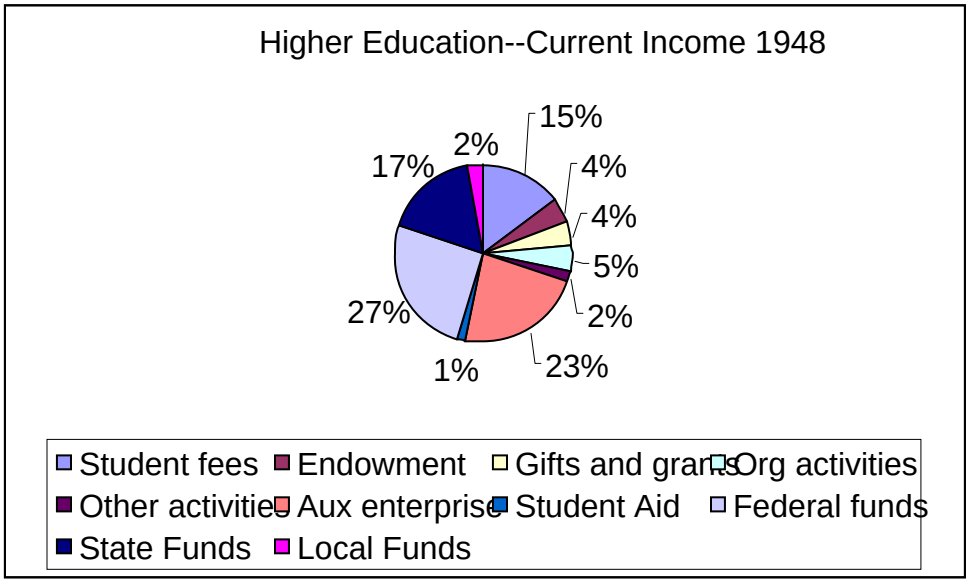


Figure 5-17



The data above show the increasing share of higher education current income that is derived from government sources. This does not include government subsidies for plant and equipment, or land. We actually see a gradual reduction in governments share until the 1936, between 1920 and 1934, the percentage of higher education current income from government funding declines from a high of 37.5% to 28.4%. Beginning in

1936, there is an increase to 30.8% continuing through 1970, where government funds make up 52.9% of higher education current income. This growth is documented on the following table and graph.

Table 5-15

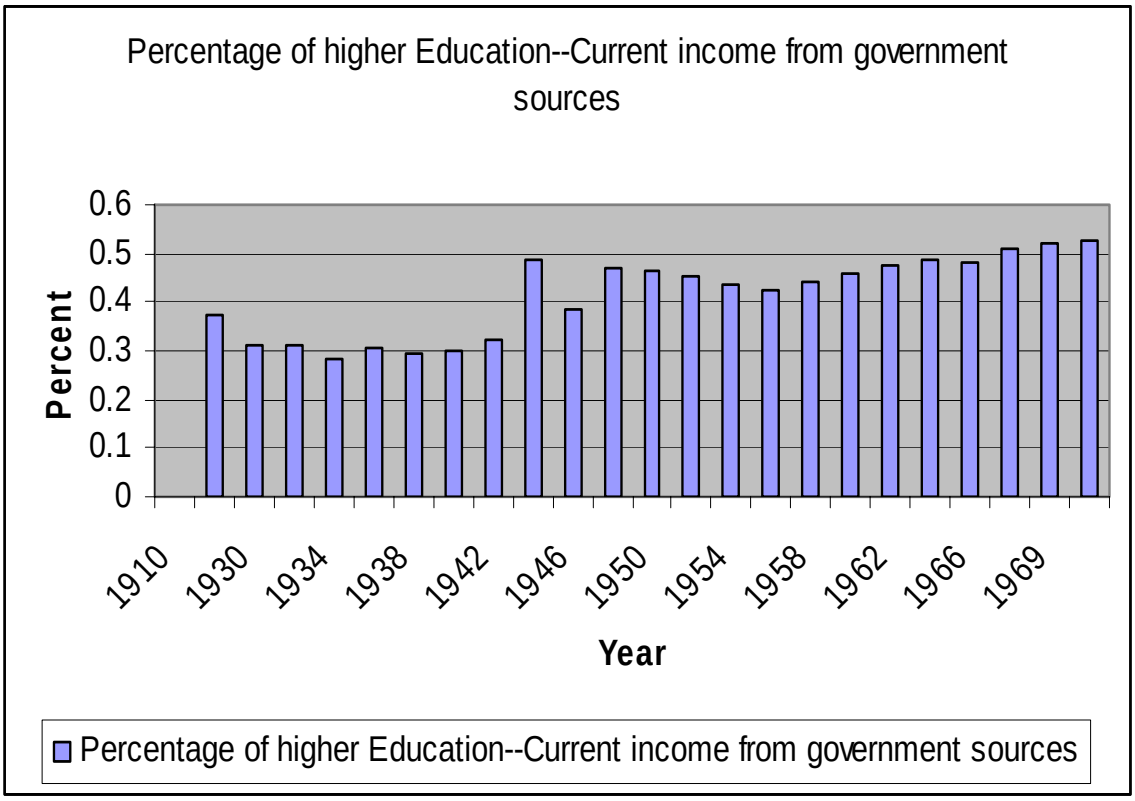
Percentage of Higher Education--Current Income From Government Sources 1920-1970

Source: US Census Bureau, *Historical Statistics of the United States: Colonial Times to 1970*

Series: H 716-727

Year	Government Percent
1920	0.375
1930	0.30991
1932	0.309187
1934	0.283951
1936	0.307692
1938	0.294028
1940	0.299301
1942	0.321429
1944	0.486151
1946	0.387511
1948	0.468673
1950	0.466105
1952	0.455113
1954	0.433469
1956	0.423813
1958	0.440422
1960	0.459039
1962	0.473146
1964	0.488265
1966	0.478718
1968	0.507043
1969	0.518411
1970	0.528654

Figure 5-18



As the preceding information shows, there is gradual increase in the percentage of higher income current income from government sources beginning in the middle of the 1930s. This gradual increase becomes dramatic following World War II with government funds approaching, and then exceeding 50% of all higher education current income funds. These data do not include the grants of land, equipment, and buildings that also occur during this period. In addition, the category of auxiliary enterprises and activities includes revenues generated from university dormitories, cafeterias, and other sources that are very likely housed in buildings paid for all, or in part by government funds.

Table 5-16

From: Detailed Occupation of the economically Active population: 1900 to 1970[41]

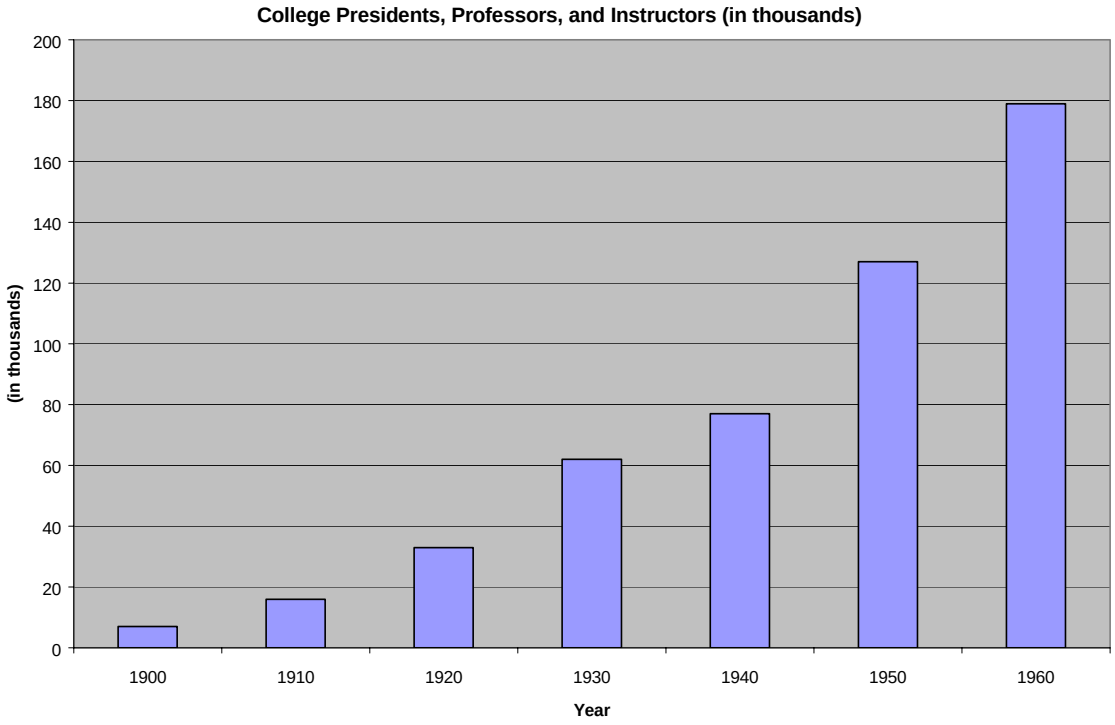
l[l**n thousands of persons 14 years and over, except as indicated**
"N.e.c." means not elsewhere classified.
Census data for 1900 as of June 1; 1910, April 15; 1920, Jan 1; 1930-1970, April 1]

Time	College Presidents, Professors, and instructors N.e.c.
1900	7
1910	16
1920	33
1930	62
1940	77
1950	127
1960	179

In the year 1900, there were roughly 7,000 college presidents, professors, and instructors in the United States of America. Between 1900 and 1910 this number increased by 9,000 to 16,000, prior to the 1940s, there was a trend of increased growth in university professions. However, by 1930 there were still only 62,000 Higher education professionals. This number takes off between the 1940 and 1950. During this period, the number of college presidents, professors and instructors increases from 77,000 to 127,000, a fifty thousand increase. There is clearly a sharp increase in the number of college presidents, professors, and instructors during the 1940s. This trend continues to the numbers for 1960. In 1960, there were 179,000 college presidents, professors, and instructors in the United States. This is a 25.5 fold increase in the profession.

[41] United States Bureau of the Census, *Historical Statistics of the United States: Colonial Times to 1970, Bicentennial Edition* (Washington D.C.) P. 140.

Figure 5-19
College Presidents, Professors, and Instructors

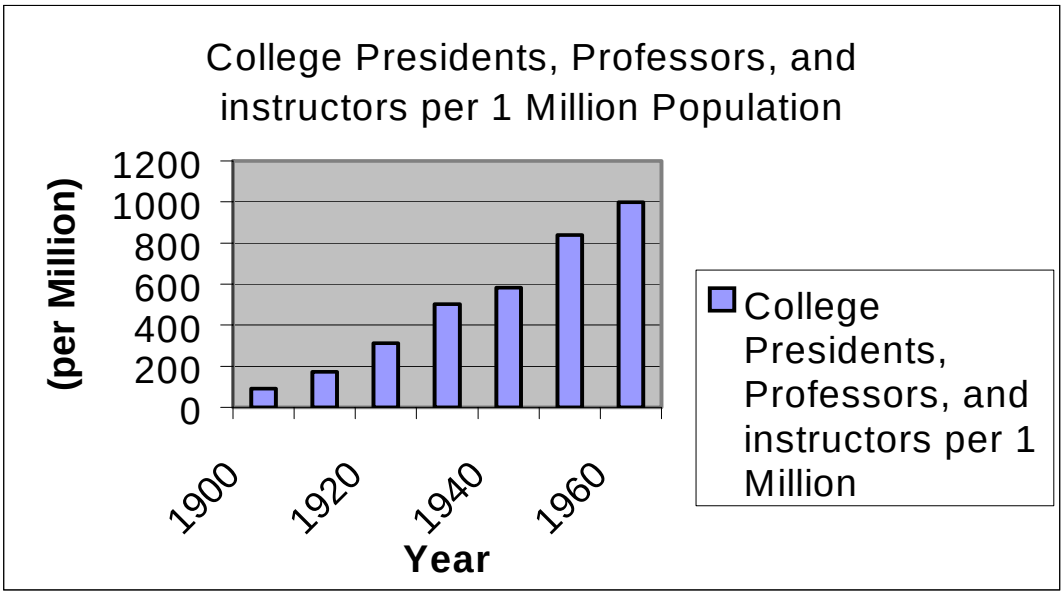


The Table above gives a picture of the growth in College presidents, professors, and instructors during the period 1900 to 1960. The growth is significant and demonstrates the 25-fold increase since 1900 and the increase of 172,000 college presidents, professors, and instructors over the period. In addition, the increase between 1920 and 1940 from 33,000 to 77,000 is more than a doubling of the 1930 numbers.

This increase corresponds to an increase in total US population from roughly 76 million in 1900 to 179 million in 1960 a 2.35-fold increase with the 25.5-fold increase in university professionals. This information is another indication of the increased share of

over all employment in the higher education field over this time frame. This indicates a shift of resources, labor being a proxy, from other industries to higher education.

Figure 5-20



In the graph above, the number of College presidents, professors, and instructors can be seen to increase per 1 million population significantly over the whole period. Over the period 1920 to 1960, the number of college presidents, professors, and instructors per 1 million population increases from 311.259 per million population to 998.199 per million population in the United States. This is a significant increase and this increase demonstrates an increase in the proportion of individuals entering the higher education work force. Over the period, 1900 to 1960 there is over a 100-fold increase in the number of college presidents, professors, and instructors per 1 million population.

The data presented in the tables and charts above indicates a large increase in the employment of university educators over the period under consideration. The ratio between academically employed higher education professionals and the population indicates a significant shift of labor away from other areas of the economy into higher education. Why did this take place? Who is paying for it? In addition, do the answer to these questions fall in line with the theory laid out in chapter 4 and the implications discussed earlier.

Higher Education: Implications

Beginning in the 1930s, federal funds begin to be dispersed to private colleges and universities in addition to state institutions. The funds come at an expense; institutions receiving those funds must meet government guidelines. The guidelines change over time, but it is clear that beginning in the 1930s, there was an increased role played by government funding in higher education.

It would be difficult to say that policy makers would fund universities and colleges that did not serve to satisfy their demands for scientific output. While those goals may change over time, in the field of economics, the ability for research and theory to make scientific predictions and estimates of variables lost when governments take over portions of the market does not. The need for these predictions and estimates arises from the very nature of government activities. As such, as government activity expands, so does the demand for these predictions and estimates. In the face of growing government activity, and funding of higher education, the demands placed on the profession of economics changed over the period of 1900 to 1970.

During the period 1900 to 1970, government has grown at an accelerated pace beginning in the 1930s. During this period, corporate activities have expanded, though at a later time. In accordance with the nature of the state and large corporate entities, the demand for estimates and predictions of economic variables is of importance to those who set policy for these institutions and must manage their activities. Through funding of higher education, the demands of these institutions are communicated to those within the professions that are able to satisfy the needs of government and corporate institutions. This is seen by the growing share of higher education funding by governments. Economics is a field of study that is reliant on higher education funding to both conduct research and train future members of the profession. As such, the demands placed on it changed during the 1930s.

Economics Profession: The Rise of Mathematical Economics

The rise of mathematical economics takes place in the 1930s. Jurg Neihans makes the following comments in describing the rise of the "model-building" era of the 1930s.

> In the early 1920s the progress of economic theory seemed to have slowed almost to a standstill. Hardly any original contributions were made between 1920 and 1925. The academic establishment was dominated by historicism, institutionalism and pragmatism. The collection of facts had taken precedence over the construction of theories. Yet within twenty years economists saw their own science in a completely different light. The star of Leon Walras rose and that of Gustav Schmoller sank below the horizon.[42]

Neihans describes the beginning of the 20th century as a period of model building in science. "The era had begun in which scientists interpreted their activity as model building."[43] From the turn of the century, "It took about thirty years before this self-

[42] Jurg Neihans, *A History of Economic Theory: Classic Contributions, 1720-1980* (Baltimore: John Hopkins University Press, 1990). P. 313.
[43] Ibid., p. 313. I am not making comment on Neihans' general impression of scientific activity, but rather portraying mathematical economics rise through the eyes of its practitioners. Also of an interesting note, Neihan's description of this movement comes from a physicist Heinrich Hertz. Neihans appears to attribute this rise in model building as being initiated by physicists.

interpretation of science conquered economics. John R. Hicks talked about models in 1937 in his famous formalization of John Maynard Keynes. In the same year, Erik Lundberg presented his dynamic analysis in the form of model sequences. In his correspondence with Roy Harrod of 1938, Keynes described economics, with his inimitable power of expression, as 'a science of thinking in terms of models joined to the art of choosing models which are relevant to the contemporary world' (Keynes 1971-, 14:296). A little later Joseph Schumpeter (1939) claimed to have constructed a 'model of capitalist evolution.' If the use words were a guide, the model-building era in economic theory would seem to have begun in the late 1930s.

During the 1930s we see the following events.

Harold Hotelling, *Stability in Competition* 1929
Cowles Commission founded 1932-39 Colorado Springs
First volumes of *Econometrica 1933*
Simon Kuznets, *National Income, 1929-32*, 1934.
John Maynard Keynes, *General theory*1936
John R. Hicks *Mr. Keynes and the Classics* 1937 (IS/LM analysis begins)
John R. Hicks, *Value and Capital* 1939
Cowles Commission moves to University of Chicago 1939-55.

These events and many others are a small demonstration of the growth of mathematical methods in economics. As will be seen when data concerning the economics profession is examined, the beginning of mathematical economics' rise can be timed to the 1930s. The ascendancy of mathematical economics continues through the 1940s and 1950s into its position as the dominant method in economics today.

Data

Table 5-17[44]

The Level of Technique in Articles

Years	Percentage Distribution			
	No Special technique	Geometry	Algebra	Calculus or more
1892-93	95	3	2	. . . . .
1902-03	92	1	6	. . . . .
1912-13	98	1	1	. . . . .
1922-23	95	1	2	2
1932-33	80	1	8	10
1942-43	65	8	6	21
1952-53	56	6	7	31
1962-63	33	8	13	46

The information above comes from a study by Prof. George J. Stigler. In this table, it is apparent that beginning in the 1930s a significant increase in the use of mathematics takes place. The use of calculus, or more advanced mathematics is not even significant in the journals he studied until the 1920s. Mathematical methods start to show as significant percentages of journal articles beginning in the 1920s (5% mathematical, including algebra and geometry), yet dramatically increasing in the 1930s (where 19% of the articles were of a mathematical nature) and continuing on. In 1965, Stigler quotes his University of Chicago colleague Aaron Director as saying, “The science will have

[44] George J. Stigler, *Essays in the History of Economics*, “Statistical Studies in the History of Economic Thought,” (Chicago: The University of Chicago Press, 1965). P. 48.

become completely mathematical by 2002-2003, when (as Aaron Director has remarked) editors will be unable to read a non-mathematical article."[45]

It would be difficult to argue conclusively with Professor Director's prediction. Although editors may be able to read non-mathematical articles, it would be hard to find a significant number of editors who would approve publication of a journal article not based on the theories and predictions of mathematical models.

At the end of Professor Stigler's study of journal articles, we find that 46% of them involve calculus, and over 50% involve some form of mathematics. If that does not indicate a paradigm shift, it would be hard to argue against it.

Table 5--18[46]

Occupations of Authors of Economic Articles

Year	Academic	Government	Other	Total
1892-93	54	5	7	66
1902-03	57	4	16	77
1912-13	123	16	32	171
1922-23	181	9	8	198
1932-33	229.2	6.5	4.3	240
1942-43	221.8	47.1	10.1	279
1952-53	267.8	23.6	9.7	301
1962-63	367.8	17.1	9.1	394

The data above demonstrates an increase in the number of contributing authors to leading journal coming from government occupations. If we consider the increasing role that government funding has to play in the academic budget, the number of economists

[45] Ibid., p. 48.
[46] Stigler, p. 45. The study was of generalist journals in economics. These included the *Quarterly Journal of economics*, since 1892; *Journal of Political Economy*, since 1892; *American Economic Review*, since 1912; *Review of Economics and Statistics*, since 1922; and *Econometrica*, since 1932.

contributing to journals employed in part or in whole by government has increased over the period. In the articles of major journals of 1922-1923, 10.6% of the journal articles come from outside academic and government occupations. This percentage decreases throughout the period 4.04% in 1922-23, 1.79% 1932-33, 3.62% in 1942-43, 3.22% in 1952-53, and finally 2.30% in 1962-63. The main journal writings of the profession are increasingly written by professional economists within academic and government employ. These professionals do not write and research for their own satisfaction, but the satisfaction of others. They make their living in the economic profession, a profession that is increasingly pressured to produce results that satisfy the demands of its greatest clients, government and corporate policy makers and managers.

Number of Economics Doctorates Issued in the US 1920 to 1970

The information from journal articles and authors over the period indicates a paradigm shift beginning in the 1930s and taking off afterwards. This resulted in mathematical methods becoming the dominant methods in economics. There has also been a shift in production of these articles that shows increased production by a professional class of economists. The production of economic theories and research has become professionalized.

The next set of data will look at the shifting of resources into the economics profession, the relative growth of economic PhDs in the United States. This data will be compare3d with population growth to find out there has been a shift of resources (labor as a proxy) into economics. Has the field experienced growth along with the stat, higher education and the corporation?

Table 5-19
Number of Economics Doctorates Issued in the U.S.
From 1920 to 1970

Source: Historical Statistical Abstract of the United States:
1970 to Colonial Times

Year	Economics Doctorates Issued	US POP	Number of Econ degrees issued per 100 thousand	Economics Degrees issued per 1 Million Population
1970	853	204879	0.416343305	4.163433051
1969	706	202677	0.348337503	3.483375025
1968	746	200706	0.371687942	3.716879416
1967	891	198712	0.448387616	4.483876162
1966	627	196560	0.318986569	3.18986569
1965	560	194303	0.288209652	2.882096519
1964	526	191889	0.274116807	2.741168071
1963	450	189242	0.237790765	2.377907653
1962	418	186538	0.224083029	2.240830287
1961	413	183691	0.224834096	2.248340964
1960	352	180671	0.194829275	1.948292753
1959	327	177830	0.183883484	1.838834842
1958	332	174141	0.190650105	1.906501054
1957	214	171274	0.124945993	1.24945993
1956	316	168221	0.187848128	1.878481284
1955	375	165275	0.22689457	2.268945697
1954	350	162391	0.215529186	2.155291857
1953	311	159565	0.194904898	1.949048977
1952	313	156954	0.199421487	1.994214866
1951	299	154287	0.193794681	1.937946813
1950	243	151684	0.160201471	1.602014715
1949	185	149188	0.124004612	1.240046116
1948	141	146631	0.096159748	0.961597479
1947	136	144126	0.094361878	0.943618778
1946	84	141389	0.059410562	0.594105623
1945	59	139928	0.042164542	0.421645418
1944	61	138397	0.0440761	0.440760999
1943	82	136739	0.059968261	0.599682607
1942	138	134860	0.102328341	1.023283405
1941	158	133402	0.118439004	1.184390039
1940	125	132122	0.094609528	0.946095276

1939	112	131028	0.085477913	0.854779131
1938	125	129969	0.096176781	0.961767806
1937	108	128961	0.083746249	0.837462489
1936	103	128181	0.080355123	0.803551228
1935	90	127362	0.070664719	0.706647195
1934	113	126485	0.089338657	0.893386568
1933	108	125690	0.08592569	0.859256902
1932	122	124949	0.097639837	0.976398371
1931	119	124149	0.095852564	0.958525643
1930	107	123188	0.08685911	0.868591097
1929	103	121767	0.084587778	0.845877783
1928	85	120509	0.070534151	0.70534151
1927	91	119035	0.076448103	0.764481035
1926	81	117397	0.068996652	0.689966524
1925	64	115829	0.055253866	0.552538656
1924	52	114109	0.045570463	0.455704633
1923	40	111947	0.035731194	0.357311942
1922	33	110049	0.029986642	0.299866423
1921	38	108538	0.03501078	0.350107796
1920	22	106461	0.020664844	0.206648444

Figure 5-21

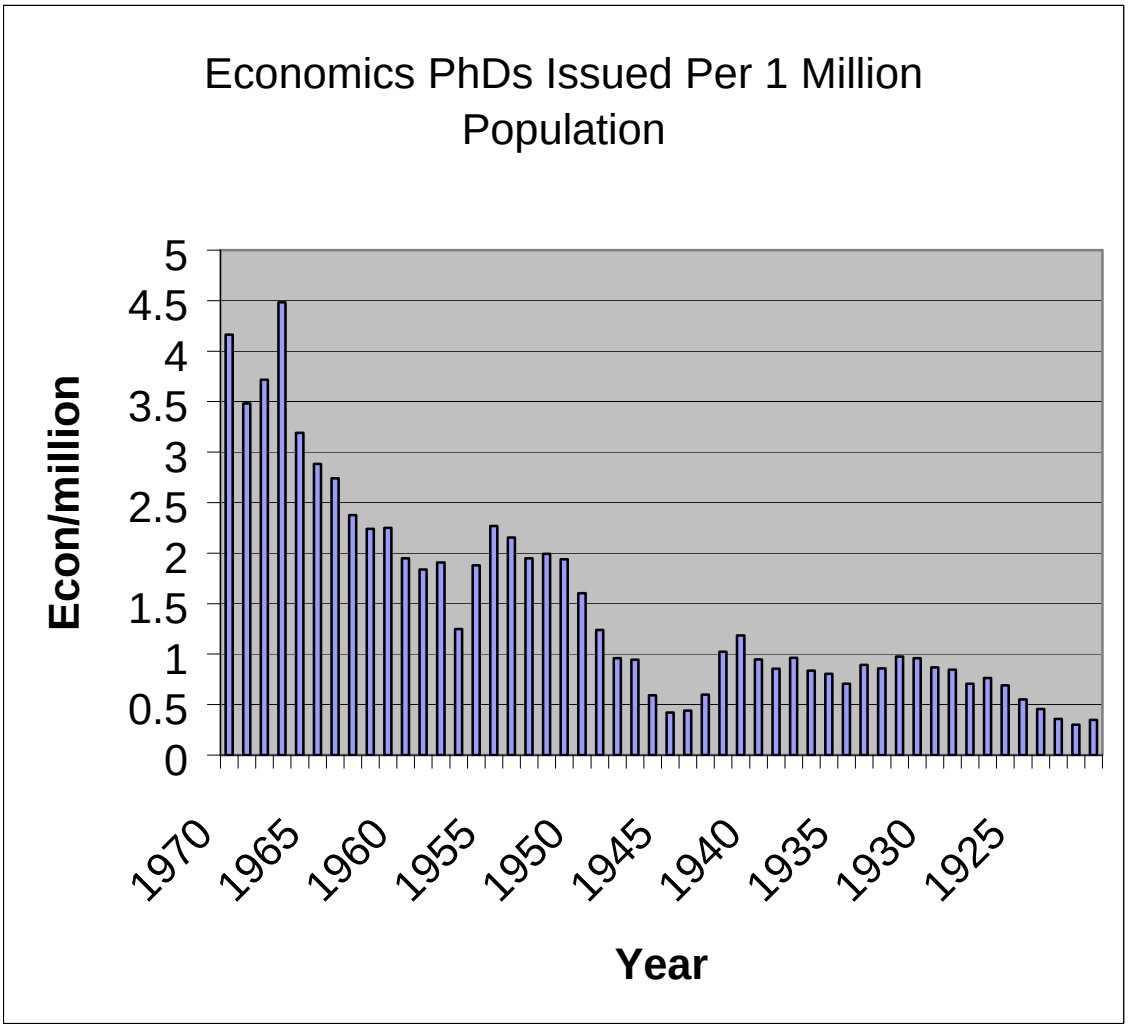
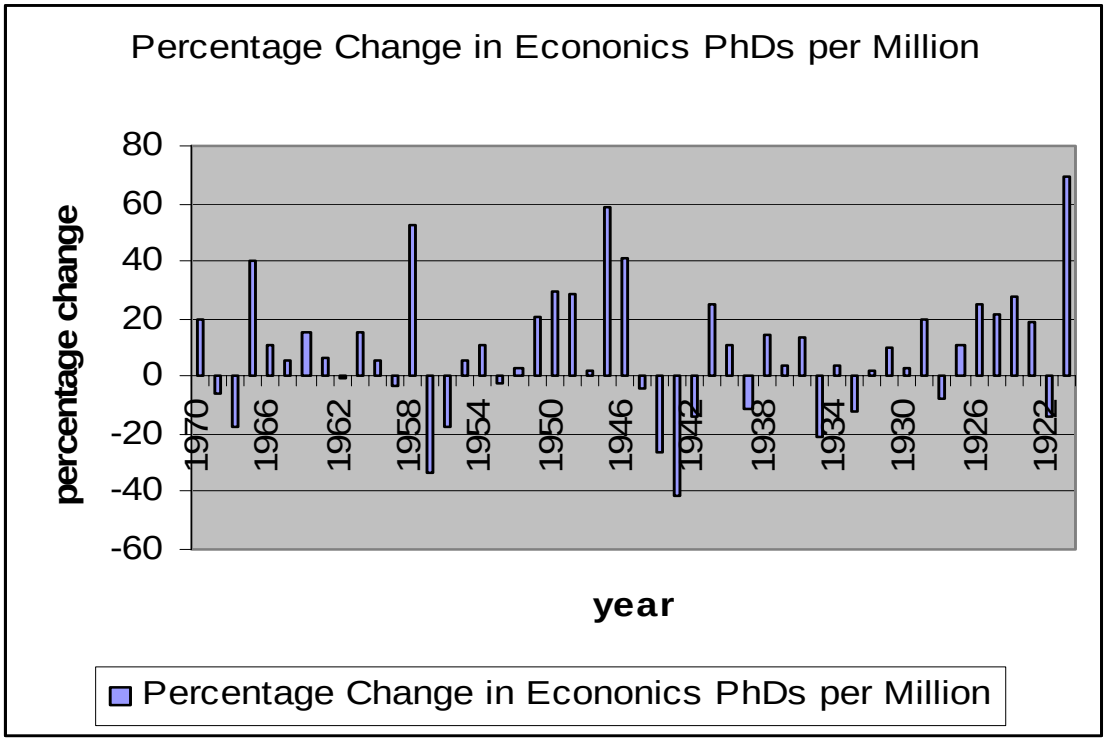

Economics PhDs Issued Per 1 Million Population
Econ/million
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1970
1965
1960
1955
1950
1945
1940
1935
1930
1925
Year

Figure 5-22



In 1920, there were 0.206 economics PhDs issued per million population in the United States. This number increases to 4.163 PhD's per million in the 1970s. This is a 1920.87% increase over the 50-year span. In the 1930s and early 1940s the number of economics PhDs per million began approaching one per million, reaching this number prior to US entry into World War II. After the conclusion of the war, the number of PhDs issued per millions makes a steady climb.

The percentage change of economic PhDs per million also exhibits greater increases after World War II. There was some significant growth also in the 1920s, but the magnitude of this growth was greater if we look at the later 1930s and 1940s in relation. The most rapid periods of growth take place shortly after the end of World War II and before the Korean conflict.

CHAPTER VI: CONCLUSIONS

The theory laid out in chapter 4 and based on the foundations laid out in previous chapters indicates the existence of market mechanisms in scientific research fields. The presence of such a market drives research into areas that are demanded by institutions outside of scientific fields. The scientist, to make a living, must satisfy the perceived needs of those outside of the scientific profession. Scientists cannot sustain themselves inside the ivory tower; they require the financial support of individuals outside that tower to fund research and for income. As such, institutions outside the scientific community determine the levels of funding for a research program. This creates demand for some research and little or no demand for other research. Paradigms in supplying theories and research are dictated too through the market for ideas. Paradigms that supply research and theories that are perceived to meet the demands of those who purchase, or fund them are more successful than those that fail to meet these demands.

If a change in institutions occurs to where these demands change, then it becomes a crisis in scientific fields where these changes occur. In the 1930s and 1940s such a change in institutions occurred. The growth of government in the United States, and a bit later the large corporation resulted in a change in the quantity and nature of scientific research, specifically in economics. This rise was demonstrated in the beginning of this chapter. Indications from the data were that government (federal, state, and local) grew at an accelerated rate beginning in the 1930s and 1940s. This growth was found in all levels

of government, but federal growth exceeded that of state and local governments. This is an indication of centralization in the structure of government in the United States. In addition, there was a shifting of resources from private uses to government control. The percentage of the civilian labor force employed by governments (federal, state, and local) rose dramatically over the period 1900 to 1970, an acceleration of this growth took place in the 1930s and 1940s.

The data on the growth of government supports the idea that there was a structural change in the growth of government beginning in the 1930s, and continuing into the 1940s. The nature of government growth leads to increased demand for theories and research, perceived as objective and scientific, to both manage that growth and justify it.[47] In the same manner, mathematical economics results may be used to oppose state interventions. Regardless, governments need some form of predictions and estimates to justify and manage its activities.

The growth of the corporation in America is a less relevant, but still important change in relation to mathematical economics. The separation of ownership and management creates a need for estimates and predictions that are perceived as objective and scientific. For managers to convince ownership of the profitability of continuing existing projects, or start new projects, some non-subjective means are useful. As stated earlier, these predictions are useful, but not perceived as absolute, if that were the case; then owners would simply replace managers with economic models, are avoid any sort of

[47] This is not to say that the growth of mathematical methods in economics is purely a socialist, or interventionist tool. Mathematical economists may take many different positions on government interventions based on various assumptions. Rather in order to justify and manage government interventions, perceived scientific and objective estimates and predictions of economic variables are necessary for the smooth operation of large government. Whether these estimates and predictions are true is not the case, rather whether they are perceived as being useful to those who fund and purchase the results. Mathematical methods may be used to oppose government actions as well as support them.

subjective valuations or predictions of future valuations. Vertical integration, also presents issues that mathematical economics can be useful in dealing with. As firms integrate vertically, the prices of intermediary goods are no longer available. What are the internally produced components of a widget worth? Mathematical methods again claim to produce scientific and objective valuations with which managers can make decisions.

In light of the growth of government and the corporate entity in America, the next step was to examine the field of higher education. It is expected that increased demand for theories and research aimed at satisfying the needs of government and corporate planners and managers would result in both an increase in dollars spent by these institutions and the proportion of this spending relative to non-governmental and corporate spending. Data on private corporate funding of higher education was not available, but information regarding government funding of higher education was used to demonstrate the government component of this change. It was found that government support of higher education, as well as the nature of that funding has changed dramatically after the 1930s. The 1930s demonstrate the first use of government funding to private colleges and universities in peacetime. Government funding of state and local institutions increased as well. The 1930s and 1940s were seen as the period in time when government funding increased relative to private funding in higher education. The historical trend of government funding coming with no or few strings attached had also changed during this period, as evidenced by the second Morrill Act. Land grant institutions, the “Aggie”, colleges were now under direction as to what fields they could use federal funds for, this shift was to the mechanical and agricultural fields, at the expense of other fields.

Government funding for research also increased dramatically during the period 1900 to 1970, by the end of the period federal research dollars accounted for 83% of the nations research funding. Government intervention in the higher education market is made apparent by the proportion of higher education income that comes from government funding this percentage also made large moves that put the timing of increased government funding for higher education in the 1930s and 1940s. Large-scale increases begin in the 1940s when government student aid becomes available to veterans of the Second World War. By 1946, the percentage of funding to universities and colleges current income exceeds 46%, from a range of less that 32% prior to the war. We see intensive increases in the percentage increase until the 1970 where over 50% of higher education current income comes from government funding. These numbers also exclude non-current income such as grants and loans for buildings and equipment.

There was also a shift that took place of resources into higher education over the period. This shift accelerates between 1930 and 1940, timing it as well with that of government growth and spending on higher education. Using college presidents, professors and instructors as a proxy for resources, the data supports the theory outlining increased growth of higher education in relation to increased government growth and the rise of mathematical methods in economics.

The 1930s and 1940s are also significant in the rise of mathematical methods in economics. Historians of thought such as Jurg Niehans describe the 1930s as the beginning of model building in economics. A number of prominent books and institutions make there appearance in the 1930s and 1940s. Data from George J Stigler's *Essays in the history of Economics*, "Statistical Studies in the History of economic Thought," also

support this claim. There is a significant increase in the use of mathematical methods in economics in the 1930s and 1940s. Prior to this period there were few if any mathematical based articles in the major journals of the time. This demonstrates the timing of the rise of mathematical methods in economics.

Stigler's data also suggests that the days of the independent scholar also ended about this time. The profession comes to be dominated by academic and government economists. The profession has become increasingly professionalized since the 1920s and 1930s. This corresponds to the theory outlined earlier, if the profession becomes professionalized, more economists are writing for outside sources. There livings are now made dependent upon the demand for economic theories and research. The main demanders of this research are government and to some degree corporate institutions, specifically the managers and policy makers. Thus, the picture unfolds of a profession, growing and becoming more professionalized meeting the demands of government and large corporate institutions. As such, the paradigm shift of the 1930s and 1940s in economics appears to be demand driven. The changes in what was demanded of the economics profession were the direct result of government growth and to minor degree the growth of large-scale corporations. The policy makers and managers inside these institutions demand specific results from theory and research due to the nature of the institutions themselves. Mathematical economics was best able to provide the estimates and predictions needed by the policy makers and managers within these institutions.

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