1.0 INTRODUCTION:

Economists typically view their discipline as a progressive science in which superior new ideas relentlessly supplant inferior old ones in a Darwinian struggle toward the truth. The roots of the debate trace back to the original mercantilist writers of the pre-classical era 1550-1770. Those writers argued that a nation's stock of precious metals constituted the source of its plenty (wealth), power, prestige, and prosperity. Denouncing the mercantilist identification of wealth with precious metals, Adam Smith observed that national wealth consists not of specie or bullion but rather of stocks of productive resources-land, labour, and capital – and the efficiency with which they are used. To some extent, then, the economist is required to live with state preferences, and if politics is the art of the possible, economists who aspire to exert influence on policy choices are obliged to judge what the possible is in any given problem area and to measure the expected benefits from what is possible against the costs of achieving it. One consequence is that it is often much easier to achieve small improvements to existing policies than to effect major new departures.

Unfortunately, the training received by an economics graduated will often do little to prepare him for the complexities of the tasks. In fact, there has grown up, a narrowly scientific view which is a far cry from the concern of earlier generations with questions of political economy. Here, the universities of developing countries are by no means immune from this type of bias and in consequence,

modern economics is largely silent on the nature of the state as an economic agent. Thus, the economics graduate may find himself "all dressed up with nowhere to go" – brimming with knowledge of refined economic theory and sophisticated econometric techniques, but innocent of ideas on how to translate this knowledge into improved policies (of the 21st century). It is against this background that the rest of this paper is divided into five sections. Section two looks at the economic theories and quantitatives; section three examines the schooling and teaching of economics. Economics information infrastructure is the subject of section four; while section five discusses economics Nobel prizing. And finally, section six concludes the paper.

2.0 ECONOMICS THEORIES AND QUANTITATIVES

Economics in the first half of the 20th century was much more of a social science. Writers such as Irving Fisher and John Maynord Keynes stressed psychological factors in their explanations of economic behaviour. With the mathematical revolution that began to take off in the 1940s with the likes of John Hicks and Paul Sammuelson, economic agents began to be more explicitly optimizing in the 1950s, economists who began formulizing the micro foundations of Keynes developed more rational models. Eventually the models came to include agents that detractors called "hyperrational". The aesthetic in the field became that if the agents in model A are smarter than the agents in model B, then model A is better than model B. Thus, the IQ of Homo Economics became bounded only by the IQ of the smartest economic theorist.

Although we can get the wrong impression reading economics textbooks and journal articles, most economists are happy to admit they know many people whose reasoning is quite flawed. When passed on why it is reasonable to base economic models exclusively on rational representative agents, while at the same time thinking that most of the people they interact with are at least occasionally bozos, typically some kind of evolution plus markets argument is offered once these quasi-rationals started interacting with rational types, the rationals would quickly take all their money after which the quasi would either learn or would be rendered economically irrelevant. However, when rational agents interact with

quasi-rational agents, the rational agents cannot be expected either to take all the quasi's money, or to set prices unilaterally. Here, psychologists, sociologists and anthropologists might help us improve our characterizations of economic behaviour, but economists are the only social scientists with the tools to analyze what happens in the market contexts.

Indeed, good theory starts from a good question and doest not cheat by adding enough conditions so as to assume the answer. Good theory is derived from sensible long-term research goals and strives to take at least a small step toward some vision. It is a creative endeavor where innovation is desirable, even if the new ideas and methods may cause initial discomfort. Here, surprising conclusions can be wonderful and successful theory frequently leads to explanations that validate one's common sense, at least in retrospect. On the role of mathematics in economics, a consensus has developed in the economics profession that one is justified in using whatever mathematics or statistics or any other formal tools, to formulate and solve a worthwhile problem effectively. Needed techniques cannot be criticized as "too much", although unnecessarily fancy and complicated methodologies which serve more to show off the author's skills than to advance understanding of a genuine economic problem should continue to be discouraged by the norms of our discipline. In considering interdisciplinary work, the "new" political economy has emerged as a promising field. Here, finance has had a huge influence in economic theory, stimulating much of our large and important literature on economics with uncertainty and

asymmetric information; rational expectation and contract theory. A newer bend is the influence of results from operations research and computer science on topics in economic theory such as complexity, parallel processing of information, stochastic versus deterministic systems, and computational techniques. However, it is predicted that biology and engineering will be the interdisciplinary influences of the future. For biology or cognitive neuroscience; the link will be the relation between biological bases of behaviour and rational choice. The potential new connections from engineering to economics operate through the importance of technology. A more local version of interdisciplinary work is emerging within economics: the traditional distinction between microeconomic theory and macroeconomic theory is disappearing. The line has been bluhed by the view that macroeconomic should be based on microeconomic foundations and general equilibrium theory. Dynamic economic theory is the blaned of these two areas, which offers an interesting and important area for future research.

At this juncture, mathematical economics strays onto the turf of theoretical and applied econometrics since it seeks to use economic models to organize economic data. Thus, there has been substantial controversy about the methods and conclusions of each area. Some of this controversy is a natural part of the way that economists learn. In this regard, it is frequently the case that applied econometrics poses challenges to mathematical economics. However, controversy over methods can sometimes interfere with accumulation of knowledge. Econometricians have similarly suggested that one learns little from

investigations using the methods of mathematical economics. For this reason, it is important to look critically at the differences that separate studies using the methods of econometrics. As we shall see, a key strength of the mathematical economics approach is that it permits the researcher to focus the evaluation of a model on a specific subset of its empirical implications. To look critically at the methodological differences, it may be useful to break the activities of econometricians into two general topics: selection of parameters (estimation) and evaluation of economic models. Theoretical econometricians work to devise procedures for conducting each of these activities while applied econometricians utilize these procedures in the context of specific economic problems and interpret the results. For concreteness, let vector of parameters be β and the vector of model implication be μ. Solving a model involves constructing a function, $\mu=g(\beta)$ that indicates how model implications are related to parameters. The business of econometrics, then, is to determine ways of estimating the parameters β and evaluating whether the implications μ are reliably close to some empirical counterparts. The empirical counterparts may be the coefficients of an unconstrained vector autoregression. The estimation of the β parameters thus involves choosing the model parameters so as to maximize the fit of a constrained vector autoregression; model evaluation involves a comparison of this fit with that of an unconstrained time series model. Mathematical Economics then involves selection of values of the parameters β and the comparison of some model implication μ with some empirical counterparts, which results in an evaluation of the model. Thus, it shares a formal structure with econometric research. This

identification of a common structure is important for three reason: the differences in the two methods must be, at least on some level, ones of degree rather than kind; that the common structure also indicates why the two methods have been substitutes in research activity; and this common structure also indicates the potential for approaches that combine the best attributes of mathematical economics and econometrics. However, it is notable that mathematical economics, as an abstraction of reality, nearly always delivers a probability model that is remarkably detailed in its implications and, hence, is too simple for direct econometric implementation. The key implication of this essential simplicity is that there is always some way to reject econometrically a mathematical economic theory with certainty. Indeed, the growth of business cycle analysis using the mathematical economics approach has arisen because there is a set of generally agreed-upon procedures that makes feasible an "**adaptive modeling strategy**". That is, a researcher can look at a set of existing models, understand how and why they work, determine a new line of inquiry to be pursued, and evaluate new results.

The main challenge to econometrics therefore is to devise ways to mimic mathematical economics power in systematic model development, while adding the discipline of statistical inference and of replicability (see King, 1995). Obviously, the development of such new econometric methods is essential for modern macroeconomic analysis. At present, it is the last stage of the mathematical economics approach that is frequently most controversial, i.e. the

evaluation of new results. This controversy arises for two reasons: lack of generally agreed-upon criteria and lack of information on the statistical significance of new results. On the former front, it seems impossible to produce a uniform practice, and it is perhaps undesirable to try to do so: the criteria by which results are evaluated has always been part of the "**art**" of econometrics. But on the latter, we can make progress. As already noted, the main challenge for the econometric theory is to derive procedure that can be used when we know ex-ante that the model or models under study are badly incomplete. There are promising initial efforts under way and there two stages in this procedure: parameter estimation and model evaluation. The strength of the mathematical economics approach in terms of the selection of parameters is that it is transparent. It is relatively easy to determine which features of the real world data are important for determining the value of a parameter used in constructing the model economy. This approach also proved opportunities for econometric: these are for learning about the features of the data that are most informative about particular parameters especially dynamic ones, and how to organize data in exploratory empirical investigations. A common problem in applied econometrics is that a researcher may have little a prior idea about which features of the data are most likely to be informative about certain parameters, particularly parameters that describe certain dynamic response. But mathematical economics can provide an important means of learning about this dependence: they can indicate whether economic responses change sharply in response to parameter variation, which is necessary for precise estimation.

However, the rapidly emerging fields of computational economic provides an important set of tools that an increasing number of economists will need to acquire in order to understand and do state-of-the-art research in virtually all areas of economics. Here, topics range from very applied, policy oriented applications of computational methods, to highly theoretical and mathematically complex analyses of algorithms and numerical methods. It pertinent to emphasis the unique contributions of computational methods in economics, by focusing on problems for which well develop solutions are not already available from the literature in operations research, numerical methods and computer science. As well as covering relatively mature areas in the field, a more speculative frontier topics include recently discovered computational innovations and research results. Specifically, the economic topics include computable general equilibrium modeling; computation of equilibrium infinite games; computational methods for macroeconomics models; mechanics of forming and estimating dynamic linear economies; non-linear pricing mechanism design and sectoral models. The computer science topics includes parallel computation; artificial intelligence for encoding and adapting in dynamic economies and modeling languages in computational economics (**GAMS**). Topics in numerical methods include modeling languages in computational economics; mathematic for economists; approximation and projection methods for dynamic optimization; numerical dynamic programming in economics; monte-carlo simulation and numerical integration.

Indeed, computer science and numerical analysis are important subjects in their own right and the modern economics specialists must give them some careful attention. Here, procedural programmes are very essential and must go through three processes before it is ready to be executed: translation (compilation), linking and loading (see Nwaobi, 1998). The translator (compiler) programme translates the source code into object code (machine language code). The linker or linkage editor combines the various parts and library routines into one chunk of object code while the loader programme loads the object code and its appended library functions and instructions into main memory for execution. This language can be grouped in three categories; business, scientific and multipurpose. Business languages (such as **COBOL** and **PRG**) are designed to be effective tools for developing business information systems. The strength of these languages lies in their ability to store, retrieve and manipulate alphanumeric data. Scientific language (such as **FORTRAN** and **APL**) are algebraic/formula type languages, which are specifically designed to meet typical scientific processing requirements such as matrix manipulation, precision calculations, iterative processing, the expression and resolution of mathematical equations, etc. Again, multipurpose languages (such as **BASIC, PASCAL,** AND **C**) are equally effective for both business and scientific applications.

However, higher level languages are flexible development tool that enable users and programmers to develop applications by describing to the computer what they

want rather than by writing a procedure programme. By using a menu system, it allow users to specify what they require, rather than describe the procedures by which these requirements are to be met. Indeed, these are object oriented programming language which shift the focus from how a programme performs its tasks to the data which is being processed. By putting the Data and its related processes (or methods) together inside an object (a technique refer to as encapsulation), the model the programme construct to represent the system is much closer to the real world. These objects may be extended by inheriting the behaviour of existing object. This allows programs to be changed to adapt to new requirements, extended the original code without actually rewriting it. In fact, this object oriented programming is hoped to be a solution to the problem of programme maintenance, a problem brought into focus by the needs for computer system to cope with dates before and after the year 2000 (see Nwaobi, 1999b). Popular tools for these are Microsoft Visual Programming Tools (Visual C+ + and Visual Basic) or Borland Delphi. A visual front end of a programme can be coded with such a tool as Visual Basic, while a more efficient programme language such as C+ + will be used to programme the process intensive back end. However, the JAVA programming language supports multi threading at the language library level with the thread class, and at the run-time level with the monitor and condition lock primitives. While the JAVA compiler is strict in its compile-time static checking, the language and run-time system are dynamic in their linking stages. Classes are linked as needed. New code modules can be linked in on demand from a variety of source, even across a network. The result

is on-line services that constantly evolve, remaining innovative and fresh. However, Visual J+ + platform improves upon the JAVA standard and explores the Visual J ++ technology in a way that requires you to use it as soon as possible. Therefore, a visual J ++ user is both the programmer who writes visual J ++ applications and the end users who use the technology that the visual J ++ provides. Hence, no more limit to the practice of quantitative economics in the 21st century.

3.0 ECONOMICS TEACHING AND SCHOOLING

The primary goal of undergraduate courses in economics is to enable students to think like economists. At a minimum, courses in macroeconomics should enable students to have a greater understanding of the economic news as it appears in the media publications than those without an education in economics. Conversely, instructors can use the headlines to set a context for the study of economics. Textbooks do a good job on many topics in macroeconomics. However, the difficulties in teaching macroeconomics go deeper than which topics to emphasize; they include questions about what analytical framework should be used to teach those concepts IS-LM-AS remained the workhorse model of macroeconomics well into the 1970s, but the model came under continued criticism on many grounds and by the mid-1980s, rational expectation approaches were evident in textbook presentations. In the late 1990s, these were a swing away from rational expectations to bounded rationality. However, the level of disagreement over macroeconomic approaches can be frustrating for academic economists, but it also offers an opportunity to teach about the way in which economists think. And students need to learn how economists working with the same data may still find it impossible to identify a unique explanation and how differences in interpretation can arise.

Indeed, the field of economics has placed too little value on the importance of teaching in recent decades. But there is at least circumstantial evidence that

economists are now devoting more attention to teaching. An example of increasing interest in the teaching of economics is the exponential growth in the number accessing the Journal of Economic Education Website (http:www.Indiana.edu/~econed/index.html). Again, there is evidence that top-ranked universities and prestigious colleges are now requiring documentation of teaching scholarship. Therefore, in the opening decades of the 21st century, it will be interesting to see whether an increased emphasis on teaching leads a change in how economics is thought and increasing student interest in economics. While class discussion, rather than extensive lecturing, is the most prominent form of instruction in higher education as whole. To get or keep in step with the rest of higher education, there are at least two types of pedagogy that seem especially well suited to the teaching of economics? One involves the idea of getting students actively invloved in the learning process. The Journal of Economic Education is filled with such activities and in relecting these activities, it is important to keep in mind the amount of time required for their use versus the potential benefits to students (see Becket, 2000; Walstad and Saunders, 1998). A second and emerging pedagogy involves the use of the Internet and many economists are making use of the Internet. Unlike the introduction of technologies of the past, the internet has the potential to involve distant learners interactively in the educational process (and internet developments are featured in the "online" section of the Journal of Economic Education). Here, the speed with which economists embrace new approaches to teaching will obviously depend to some extent on the reward structures for doing so. But ultimately, teaching

practices within departments of economics will likely move beyond the chalk-and-talk preaching mode that characterizes the 20th century style of economics teaching. Students now expect to be engaged in the learning process and appear unwilling to sit passively through lectures (Katz and Becker, 1999).

Conventionally economics departments have relied on end-of-term student evaluations of teaching as the measure of the instructional product. The primary purpose of the common end-of-course evaluation form is to provide comparative data for administrators and this heavy reliance on student evaluations is troubling for several reasons. Here, there is little reason to believe that student evaluations of teaching capture most of the elements of good teaching. Departments often misuse these scores by comparing each instructor with numerical means of medians for all instructors of the course or of like course, which results in treating the scores as if they have far more precision than they actually do and by implication damns the half below the average regardless of its level. Again, student evaluations forms usually ask few questions that deal with what education specialists say is important: active student learning and group (collaborative) learning. Although academic economists call for the use for better applications and examples in teaching, these items are among the least often asked questions on student evaluation of teaching. Although, there is lip service about implementing new technology in teaching economics, questions about the use of technology are rare on student evaluations of teaching forms; and little attention is given to student's perception of what they believe they learned. Equally; an end-

of-term student evaluation offers no feedback to the instructor on what might be done to improve teaching during that actual course.

In this 21st century, sole reliance on traditional end-of-term student evaluations of teaching should not be tolerated. For starters, student evaluations should focus on what students know; that is, what they learned. Feedback should be gathered by a variety of methods throughout the term. Here, electronic technology makes periodic assessment easily and hence students need not complete assessment instruments in a classroom instead, they can be required to complete periodic questionnaires as part of a course requirement, with an option for anonymous response available to students who desire it. Other methods of assessing teachers include classroom observation, peer review of teaching materials, drop rates, and patterns of subsequent student behavior. Multiple choice tests area staple of assessment in economics classes, especially in large enrollment introductory classes, where they are really mandated by cost considerations. These multiple-choice tests are crude instruments for assessing student learning, and as such, should not be the sole method of assessment in any course. However, they can be used in educationally sound ways and no matter how they are delivered, multiple-choice or even open-ended test questions do not involve students in what economists do. To get students to think like economists, we need to find ways to move beyond highly structured tests that typically do not challenge students beyond a recall cognitive level.

Although the number of economics graduate students expanded substantially in the 1950s and 1960s, the fundamental structure of graduate economic education did not change much at all in the second half of the 20th century, however, the structure of economic education will undergo profound changes in next 50 years. The first major change that occurred is external to economics; geographic place was still central to education. In the future, geographic place has become far less important; "brand" is far more important. Going to university or college used to means going to a particular geographic place; for a few of the top colleges and universities that is still the case, but for a majority of students it no longer means that. Virtual universities, collections of scholars from around the world who have combined into as accredited program of study in a particular field, have grown enormously, and have significantly displaced many geographically base programs. The burgeoning growth of these virtual universities has led to an increased importance of accrediting agencies, such as International University Accreditation Association (IUAA), which was created by an international consortium of universities. Indeed, the development of these virtual universities was driven by developments in information and communications technology. Complete virtual classes, where each student is virtually recreated in an interactive classroom setting regardless of where they are, have replaced in-person classes. Entrance into a typical university graduate program in economics now allows students a choice of 30virtual discussion groups, 40 virtual classes, and 40 virtual seminars in economics. With the enormous expansion of virtual universities has come a narrowing of IUAA accredited schools, which has meant

a significant shakeup in structure for graduate economics program. Here, some stand-above universities have entered into virtual partnerships that increase course options for that student. The others have merged into conservations and they given consortium degrees. Again the consortiums that developed from existing nonprofit universities still have their geographic homes where students can live if they choose, but a graduate student accepted into a “virtual university” car reside at any locations that comprise the physical university or can reside at none of them.

In the past, graduate work in economics” was rather undimensional. Becoming “an economists” meant studying economics at a graduate program in economics, and the majority of graduate programs were quite homogeneous. In the first years of graduate school, in particular, everyone learned essentially the same set of models, the same approaches. In future, the majority of consortiums granting economic related degrees have multiple tracks. People no longer become generic economists; instead graduates are clearly designated as specialists in public finance, health care, macro forecasting, forensic economics, industrial relations, etc. To be sure, graduate study in economics still starts with one semester of general core courses: one in micro, one in complex systems analysis, and one in statistics. However, these courses are not technical courses as there were in the past; they are survey courses given to acquaint students with the broad field of economics. Immediately after these courses, students begin specialized study in one, or sometimes two, areas of specialty. Each of these areas of specialties, or

tracks, has its own set of required courses and knowledge: economy theory track, and general economics track. Indeed, the increased specialization has been accompanied by a redefinition of boundaries of graduate economics programs within institutions. In the past, these boundaries have broken down. Most of the existing specialties that comprise economics evolved out of a combination of schools or programs within schools. For example, a person studying health economics now will go to a health economics program that evolved out of a combination of economics programs, medical school programs and public policy school programs. In fact, one might say that in the future, there are no longer "economists", but specialized economists. The changing of the boundaries did not come easily and involved much infighting. The evolution of the changes is worth recounting. In the closing decades of the 20th century, graduate economics programs provided the professors to teach in public policy and business schools. As these programs grew, and become more specialized and rigorous, these schools became self-replicating. They hired their own Ph.D graduates to teach in their programs, developed their own journals and split off from economics per se. Public policy schools in particular developed their own brand of economics, which grew in importance throughout the beginning of the 21st century. By mid-century, they will become the major suppliers of economists not only to their own programs but to other programs as well, as traditional graduate programs in economics shrank in size or merged into virtual universities.

To set the stage for how economics will change in the first half of the 21st century, it is useful to begin by thinking back to the evolution of economics in the second half of the 20th century. Twentieth century economics generally was called neoclassical economics, although the term does not do justice to the transformation of economics during that century. By year 2000, the economics profession had changed fundamentally, and we often use 2000 as the end of the neoclassical era and the beginning of the New Millennium Era (see Colander 2000; Solow 1997). Indeed, new millennium economists' still use models, but they are quite different models than the deductive models of the 1990s. Modern models are more like weather models in the late 1990s. These new models come to many of the same conclusions as the old models; economists still believe price incentives are important and that markets solve coordination problems, but that belief is not held with the almost religious conviction with which it was held in the neoclassical era. Specifically, new millennium economics do not base policy on the neoclassical welfare theories, which were part of its broader "right price" view of policy. That view of policy has been replaced by our current "right institutions" view of policy. This is not to say that the optimal rationing ideas found in the welfare theories are not still used – they are. It is only to say that they are used as a subcomponent of a broader institutional policy analysis and they provide insight given institutions, not about institutions.

Again, economists, in future, will do empirical work in a wider variety of ways than they did at the turn of the millennium. They will both create data and

analyze it. Experimental economics is now as extremely important way of creating data; interestingly, it only began in the late 20th century. Economists today also use natural experiments and randomized field trials to create data much more than they did earlier. Hence, new millennium economists tease information out of data sets with complex statistical programs that automatically report correlations under multiple specifications and undertake standard robustness tests of these correlations. Such statistical analysis is routinely done with all data sets. Hence, New Millennium economists do not believe that they are testing a particular model, which was deduced from first principles; instead they are simply looking for possibly exploitable pattern in the data. Thus, the **Loose-fitting position of 50 years ago has changed to a loose – fitting pragmatism.** Indeed, the movement of economists away from deductive principles was based on an evolving belief that complexity science was the appropriate domain for economics. New Millennium economics divides phenomena into those which are susceptible to what might be called "structural simplification", in which models with linear dynamics and unique analytic solutions are used, and those susceptible to "replicative process simplification" in which data are simplified into non-linear dynamic models with no unique analytic solution. Here, the replicative process research program (or complexity approach) follows a different pattern. Instead of beginning from certain principles and assuming linear dynamics, a wide variety of organizing principles and dynamics became conceivable. The 1990s saw the beginning of complexity science. In the present time, complexity science had developed to the point where most scientists accepted the view that the old-style

research path worked well for structurally simply systems, but the complexity path was necessary for complex systems. And most economic researchers believed that the economy was a complex system that belonged with complexity science.

For example, in the 1990s, an active research program in economics looked for microeconomic foundations on which to build macroeconomic theories. The methodology held that if aggregate macroeconomic results were to be trusted, they had to be derived from micro-foundations, which were built on rationality, maximizing behaviour. The acceptance that economics was a complex system owed that belief and we now believe that micro-foundations are contextual and that the order we observe in complex systems arises spontaneously. Essentially, complexity science finds the temporary pattern in complex systems and it does not search for general results that hold for all times; instead, it searches for temporary patterns that develop spontaneously in complex systems. Here, equilibrium may sometimes occur or it may not and complex systems are always evolving and expanding with new complex patterns emerging, making all patterns of complex systems potentially temporary. The development of computer technology was behind the complexity science development in the 1990s. The implications of this charge resonated throughout economics. For example, as late as the opening decade of the 21st century, supply and demand graphs are seldom used explicitly. Instead, the developments in computer power have allowed use of on-line dynamic simmolations in which students play scenarios. Again, in the

1990s, one pictured an economic policy analyst sitting with a pen and paper working with an analytic model-then going to the computer to test it. In the future, the picture of an economist is of a person sitting at the computer doing analytic and data analysis simultaneously, relying on computer programs that takes data, analyze it, and suggest eight or ten alternative models that fit it. Again, economic theory no longer needed to be built from deep bedrock of fundamental results; instead, it could be based on computer-aided observation and search for patterns. In the 1990s, the usual proof of a proposition in economics relied little on previously observed economic patterns and instead relied on a combination of structural assumptions and existing mathematical theories. In New Millennium economics, "proofs" in economics rely much more heavily on empirically determined economic patterns that have developed through simulation work, experiental work, and economic modeling built on generally accepted observed patterns. Thus, "abduction" replaced deduction. Of course, characteristics like rationality and maximizing behavior have not disappeared from economic analysis, but their extent and direction now need observed, not assumed. Likewise, equilibrium is a pattern that can occur and may even last for a time, but it is never assumed. Instead, it is always temporary, part of a wider "complex adaptive system" in which new patterns are constantly emerging.

An early example of the use of complexity approach in applied economic work can be seen in the work of Quirmbuh (1993), who evaluated the trade off between the degree of competition and the level of investment. In the standard view of the

1990s, if the future competition was expected to be very intense, than the current levels of investment in R&D may be lower than socially desirable. He computed hundreds of cases of different market structures, implying differing degrees of competition, and found a robust pattern that suggested that allowing collusion or monopoly to stimulate the appropriate level of R&D was usually a poor idea from a social welfare perspective. The interest here is not the result, but the method. His result was not a "theorem" in the traditional sense of economic theory, but it was a valuable policy result, because the robustness of his findings was unsuspected. Again, Peter Howitt and Robert Clower (1999) began with a number of observations which they translated into a set of rules and then built a theoretical simulation model based on these rules and studied the self-organizing patterns that emerged from the model. In other words, they "grew" their economic model rather than assuming it. In their simulation model, all economic organization, including equilibrium (or the lack of it) and markets themselves, are outcomes following from the rules about transactions costs, not assumptions. As computational costs dropped, this pattern search approach to policy expanded and became the dominant method of policy analysis. It substantially reduced the need for a deductive foundation and thereby played a role in the changing structure of economic graduate education. Initially, the economics profession fought the computer approach with the vehemence that Luddites of the 19th century and the Linotype operators of the 20th century fought technical change in their occupations. Because of deductive economists structural control of the profession in the early 21st century, initially this fight was highly successful, but, eventually,

the new technology won and computation replaced deduction as the primary workhorse of applied and theoretical economics.

Finally, the economics profession has come full circle back to the more descriptive and institutional approach, which was common a full century ago. The underlying mathematical structure of models and computational techniques that economists use in the future is, of course, much more complicated, but most economists are being trained to use these tools and not to derive them. This frees the training of graduate students to focus what textbooks of the 20th century focused on (melding together insights, numerical examples, classification, and simulations to arrive at sensible discussions of policy) and allows one to describe economists of the 21st century as the appropriately educated in search of the knowable" (as against the economist of the 20th century which are regarded as the overeducated in search of the unknowable).

4.0 ECONOMICS INFORMATION INFRASTRUCTURE:

The Internet is clearly the premier academic and research (and commercial) network. It is seen as the prototype, if not the precursor, of the information superhighway. The programs (or protocols) that access the Internet take some effort to learn, but they are certainly within the grasp of the computer literate. The major difficulty stems from the Internet's very nature: since it spans many different computer systems, the programs and the users must bridge them. Further, the entities funding the networks making up the internet have until quite recently, concentrated on building networks, rather than creating resources cataloging them or developing tools to find or easily retrieve them. However, once some basic concepts are understood, the programs can be learned as needed. It would be very wise to supplement this very succinct guide with local documentation and perhaps even a class (offered by many university computing centers). A key to understanding and using the Internet is the concept of a protocol.

Essentially, protocols are standards, implemented as programs, on each of the millions of internet computers that coordinate their operations. Some are very basic and are never seen by the typical user. For instance, a pair of protocols known as TCP/IP transmits collections of bits, known as packets, between computers on the internet, called "hosts". Higher-level protocols use TCP/IP to accomplish tasks such as electronic mail, logging onto remote hosts with the

Telnet protocol, transferring files with FTP (file transfer protocol), and easily viewing and transferring files with Gopher, or Worldwide Web.

Indeed, the easiest way to connect to the internet is to belong to an organization to which offers it: most universities, some government organizations, and an increasing number of businesses. As an alternative, many service providers sell internet connections. Their services range from connecting individuals, using a phone line and a modern, to connecting large organization with thousands of computers using dedicated, high speed leased lines. There are two types of connections to the Internet from the desktop and both involve communications software and an expansion card inside the computer. However, the most useful is a direct connection, where a computer runs the Internet protocols and is a "member" of the Internet and such a machine is known as an Internet "host".

For many economists, electronic mails, or e-mail, may be the most useful Internet protocol. It is superior to faxing because the recipient receives an electronic document that can be manipulated in a computer, not a picture of a document that must be retyped or scanned before it can be used. The two ways of organizing group discussions are through mailing lists and Usenet. In a mailing list, e-mail is sent to one address, where software automatically resends to all list subscribers. Thus, to discuss a topic with all subscribers of a mailing list, you send mail to one site, which then distribute it. On the other hand, Usenet is a discussion system with several thousand enormously diverse newsgroups. Most universities carry

Usenet and the software that accesses it. The resource section catalogs mailing lists and newsgroups for economists. And many of the most active economics mailing lists are composed of those who have no local colleagues in their field. Telnet lets one log onto a remote host, even one across the world, from your local host and almost always operates in the same way. File Transfer Protocol (FTP) may be the most complicated protocol, which stems from the variety of systems FTP traverses. Resources for economists available through it include the well – integrated source of U.S macro data Econ Data and the Penn World Trade Tables from the NBER. Like telnet, all internet always operates in the same way. Again, Gopher is an easy-to-use Internet protocol that transfers files and looks up information. Users contact these Gopher servers in one of two ways: through Gopher "client" programs that run on your local host or through Telneting to a host that offers Gopher service. The former communicate directly with Gopher servers and are faster, require fewer network resources, and best exploit the server and the user interface on the local host.

The Worldwide web is the most advanced, and paradoxically, easiest to use Internet protocol. Since it subsumes many other protocols, the only additional software many will need is an e-mail program. Here, it can view specially designed documents (which may include pictures and sound) spread across the Internet in seamless webs. The documents are connected through " hypertext" links; that is, one might be reading a short description of the civil war, and the name Lincoln is highlighted, indicating a link to a document describing him and

by pressing the enter key, one can read the document, which may be located on another machine. Basically, there are three elements of uniform resource locators (URL): the protocol to access that resource, the host, and the location of the resource on that host. A "://" separates the protocol and host, while a "/" begins the location of the data on the host. Protocols include Telnet, FTP, Gopher, and World Wide Web (http) (see Nwaobi 1998; Gelfe, 1994)

Indeed, computers will change the lives of economists. A fully networked world could offer much easier access to the working papers, articles, bibliographical information and data that lies at the heart of much research and teaching. However, the path to the future is likely to be tumultuous. After all, technological change may not only alter existing practices, but may usher in entirely different institutional arrangements. In one scenario, the technology of moving and storing information changes, but no fundamental change occurs in the relationships among librarians, publishers and readers. Although information will flow over networks, it will not be much more accessible. Publishers hold copyrights, libraries store information and journals, and they and users may pay fees for the electronic copies of materials. A second possibility is that scholarly material becomes freely available on the Internet, but is unorganized and all but impossible to find. And yet, another scenario is one in which information will be easily found and accessed.

Moving to an on-line world involves a number for issues for the profession. Although technology has made it easier to write papers, especially, through joint authorship, it takes a substantial amount of time to write a paper, and the underlying reasons for writing one more paper have not changed. The guess is that the quality of output of economists is unlikely to substantially change. However, the number of journals could either rise or fall dramatically. At least with on-line distribution, we can eliminate one inefficient selection mechanism – the cost of hard-copy distribution. Here, Journals will probably continued to provide one important selection mechanism. After all, most of the value of a hard-copy journal is in its refereeing and editorial process, and this will not change; on-line journals will provide the same services. In addition, as on-line journal can assure the reader it has the most up-to-date or final version of an article, along with any comments on it. And as on-line journals will reduce the publication lags and backlogs of the hard-copy world, their selection services will be far more timely. Again, electronic journals could count how often their papers are accessed or how often the papers were cited in another paper. Another possibility would use the feedback from earlier readers as a guide for later ones and readers could rate papers or articles, and you would consult the ratings to limit your search of interesting articles. Yet another cluster of issues revolves around whether on-line journals will maintain certain levels of quality. Any one can start an on-line journal while hard-copy journals require significant start-up effort. As with hard-copy journals, authors will submit to and readers will only read on-line journals that have high-quality articles. Thus, some countries have

legislated that in view of grants, electronic publications must be weighted equally with hard-copy publications.

To find publications, working papers and data sets, directories or Databases are essential. Without them, one is effectively in a library without a card catalog. Several indices for information for economists on the Internet already exist: Resources for Economists on the Internet and WebEc are two general indices; BibEc is a bibliographic database of on-line working papers; WoPEc is bibliography database of on-line working papers; Econ WPA is an automated archive of on-line working papers; CodEc and Econometrics Laboratory Software Archive (ELSA) are databases of programs in economics; and Guide to Available Mathematical Software (GAMS) lists various mathematical and statistical programs.

At this juncture, it is difficult to predict how the on-line world will affect teaching beyond providing articles, working papers and data sets. Currently, some publishers are supplementing principles text with on-line sites that have both instructor aids and material for students. Here, there are email discussion lists for teaching and many local lists for interaction between students and instructors. One of us requires that the book and the lectures be evaluated by students each week via e-mail and many economists now post syllabi, previous tests, exercises and exam results on web sites. Again, there are beginnings of on-line textbooks and whether these will replace or just supplement current hard-copy textbooks is

uncertain. Classroom Expernomics is an on-line and hard-copy journal with articles concerning the use of experiments in teaching economics. For example, the National Budget Simulation is a simple but well-done simulation to show tradeoffs in balancing the budget. Indeed, for existing economic journals, and potential journals of the future, the benefits of electronic publication are clear: a combination of lower cost, potentially higher visibility for editors and authors, and easier access to information for readers. In a rapidly moving technological world, some journals will ride their electronic versions to a greater prominences; and other journals will diminish in status by a failure to adapt to the on-line possibilities. Thus, for a journal considering the back end problem of on-line distribution, it would be wise to use standard Internet tools such as web browsers, HTML, and Adobe's Acrobat (PDP) format. HTML does not natively support many mathematical symbols and hence PDF is designed as "digital paper". Thus, it can accurately replicate any sort of tables or mathematical expression, along with color, movies, sound, links within and to external web sites and indexes. Clearly, a substantial amount of work on the part of many in our profession will be required. Editors and others working with journals will need to become more familiar with the Internet and the different tools that produce electronic documents. Indices will need to be further developed and economists will have to get used to supplying information for these databases. However, everyone recognizes that one of the driving forces behind the academic publishing enterprise is the tenure system. Non-tenured faculty publish so they can become tenured faculty and this is one of the contributing factors to the explosion of

academic literature. Thus, if electronic documents make publishing cheaper, this will only get worse and if tenure comes down to weighing six years of manuscripts on a scale, a lecturer will turn out as many manuscripts as they can. We therefore, suggest that universities adopt a policy of putting a limit on the number of papers they will accept for purposes of tenure review. Here, let's say that the tenure committees will only evaluate your five best papers and the authors can then focus themselves on doing a few serious pieces rather than lots of shallow ones. Consequently the review committee will have a manageable task while the readers of articles will have fewer but higher quality pieces to read.

5.0 ECONOMICS NOBEL PRIZE AWARDS:

In 1901, the noble prices were initiated in physics, chemistry, medicine or physiology, literature and peace (and to be awarded on December 10th each year). The prices were set up under the will of Alfred Bernhard Nobel (833-96), the unnamed Swedish chemist and chemical engineer who invented dynamite (1866). According to his will, the prices should be given to those who have made "the most important discovery or invention in the identified fields. And in awarding the prices no consideration whatever shall be given to the nationality of the candidate. However, in conjunction with its tercentenary celebration in 1968, the Central Bank of Sweden instituted a new awards, "***The Central Bank of Sweden Prize"*** Price in Economic Science in Memory of Alfred Nobel" on the basis of an economic commitment by the bank in perpetuity. And this award is designed to be given according to the same principles and rules as the original Nobel prices. After the Nobel foundation, the Academy, and the Central Bank had agreed on the conditions and rules for the price, the board of the Central Bank decided to initiate the price and to establish formally the agreed-upon rules (in 1969).

The basic idea of Nobel prices is to award specific achievements rather than "outstanding persons". That is, prices should be given to "those who, during the preceding years, shall have conferred the greatest benefit on mankind. Thus, it is very obvious that price in economics too should be granted for specific contributions. Indeed, the statutes prescribe that "the price shall be awarded

annually to a person who has carried out a work in economic science of the eminent significance. The price-awarding authority has tried to adhere to this principle, even though in several cases the contributions have certainly been made and published over a great number of years. By applying the basic principles of the Nobel prices, scholars with rather narrow research profiles, who have made one single path-breaking contribution, may be favoured over all-round scholars, who have made several important but no single path-breaking achievements. Moreover, there may be a "risk" that prices for specific contributions occasionally will result in a price being awarded to rather mediocre researcher. However, this is not likely to be a serious problem for awards in a social science like economics, where important scientific contributions, whether theoretical or empirical seem to require profound insights into economic issues and processes. As all discussions of Nobel prices within the Academy are confidential, it is not possible to report to outsiders the various considerations that lay behind individual prices and candidates. However, after several years of economics price awards and the choice of laureates, it may be useful to attempt some general inflections on the types of criteria that apparently have guided the price awarding authority, the Royal Swedish Academy of Sciences and its price selection committee. It may also be of interest to note some problems and difficulties that arise in connection with the selection of price-winners, that is to consider what should be meant by price worthy contributions to economic science and how various branches, methods and philosophies of economic research should be regarded in this context. Here, it is useful to begin with a rough classification of the various types

of economics price awards that have been given so far and it should be kept in mind that all such classifications are rather arbitrary because of the multidimensional nature of scientific contributions, the impossibility of defining categories that are logically parallel, and the difficulties in avoiding overlap in the classes. These awards are as follows:

1. 1969 FRISCH, RAGNAR (OSLO UNIVERSITY) AND TINBERGEN, JAN (THE NETHERLANDS SCHOOL OF ECONOMICS – MACRO ECONOMETRICS – for having developed and applied dynamic models for the analysis of economic processes.

2. 1970 SAMUELSON, PAUL (MASSACHUSEAS INSTITUTE OF TECHNOLOGY) – GENERAL EQUILIBRIUM THEORY – For the scientific work through which he has developed static and dynamic economic theory and actively contributed to raising the level of analysis in economic science.

3. 1971 KUZNETS SIMON (HARVARD UNIVERSITY) – DEVELOP-MENT ECONOMICS – for his empirically founded interpretation of economic growth which has led to new and deepened insight into the economic and social structure and process of development

4. 1972 HICKS, JOHN R (OXFORD UNIVERSITY AND ARROW,

KENNETH J. (HARVARD UNIVERSITY) – GENERAL EQUILIBRIUM THEORY – for their contributions to general economic equilibrium theory and welfare theory

5. 1973 LEONTIEF, WASSILY (HAVARD UNIVERSITY) INPUT-OUTPUT – for the development of the input-output method and for its application to important economic problems"

6. 1974 MYRDAL, GUNNAR (UNIVERSITY OF STOCKHOLM) AND VON HAYEK (FRIEDRICH AUGUST (UNIVERSITY OF FREIBURG) – Macroeconomics and institutional economics – for their pioneering work in the theory of money and economic fluctuations and for the interdependence of economic, social and institutional phenomena.

7. 1975 KANTOROVICH, LEONID (ACADEMY OF SCIENCES, MOSCOW) AND KOORMANS, TJAILING C. (YALE UNIVERISTY) – NORMATIVE ALLOCATION THEORY – for their contributions to the theory of optimum allocation of resources.

8. 1976 FRIEDMAN, MILTON (UNIVERSITY OF CHICAGO

(MACROECONOMIC S) – For his achievement in the fields of consumption analysis, monetary history and theory and for his demonstration of the complexity of stabilization policy.

9. 1977 OHIN, BERTIL (STOCKHOLM SCHOOL OF ECONOMICS) AND MEADE, JAMES (CAMBRIDGE UNIVERSITY) – International Economics – "for their path-breaking contribution to the theory of International Trade and International Capital movements".

10. 1978 SIMON, HERBERT A. (CARNEGIC-MELLON UNIVERISTY) ADMINISTRATION SCIENCE

11. 1979 SCHULTZ, THEODORE W. (UNIVERSITY OF CHICAGO) AND LEWIS ARTHUR (PRINCETON UNIVERSITY) – DEVELOPMENT ECONOMICS – for their pioneering research into economic development, with particular consideration of the problems of developing countries.

12. 1980 KLEIN, LAWRENCES, R. (UNIVERSITY OF PENNSYLVANIA) – (MACROECONOMETRICS)
For the creation of econometric models and their application to the analysis of economic fluctuations and economic policies

13. 1981 TOBIN JAMES (YALE UNIVERSITY) – MACROECONOMICS

- for the creation of econometric models ad their application to the analysis of economic fluctuations and economic policies

14. 1982 STIGLER, G.J (UNIVERSITY OF CHICAGO) – Industrial Organization – for his seminal studies of industrial structure, functioning of markets and causes and effects of public regulation

15. 1983 DEBREU, G (UNIVERITY OF CALIFONIA, BERKELGY) – General Equilibrium Theory – for having incorporated new analytical methods into economic theory and for his rigorous reformation of the theory of general equilibrium".

16. 1984 STONE, RICHARD (CAMBRIDGE UNIVERSITY) – NATIONAL INCOME ACCOUNTING – "for having made fundamental contributions to the development of systems of national accounts and hence greatly improved the basis for reformulation economic analysis".

17. 1985 FRANCO MODIGLIAN – (MASSACHUSSETS INSTITUTE OF TECHNOLOGY) – Monetary Economics – liquidity Preference and the Theory of Interest and Money.

18. 1986 JAMES M. BUCHNAN (GEORGE MASON UNIVERSITY)

- Public Finance – Public Choice Theory

19. 1987 ROBERT FLOW (MASSACHUSSETS INSTITUTE OF TECHNOLOGY) – macroeconomics – Capital and Growth Theory

20. 1988 MAURICE ALLAIS (UNIVERSITY OF PARIS) – Public Economics – Social Efficiency

21. 1989. TRYGRE HAAVELMO

22. 1990. HARRY M MARKOWITZ – Sharpe, Merton H. Miller

23. 1991. Ronald H. Cooae (University of Chicago) – Public Sector Economics – Problems of Social Cost Externalities

24. 1992. Gary S. Baker (Univeristy of Chicago) – Demography – Economics of Discrimination

25. 1993. Rober Fogel and D.C. North (University of Chicago) – Economic history – Pioneering research in the Application of Economic Models and Statistical Methods to Historical Questions

26. 1994 -

27. 1995 ROBERT E. LUCAS (UNIVERSITY OF CHICAGO) – Economic Fluctuations – Provided insights into the difficulties of using economic policy to control the economy and principal formulator of rational expectations theory

28. 1996 -

29. 1997 -

30. 1998 Amtrya Sen (Harvard University) – Welfare Economics

31. 199 Robert Mundell (New York University, Columbia) Exchange Rate Economics – he demonstrated that at a time of floating exchange rates and high capital mobility the situation in many countries today, the key region for stimulating the economy is monetary policy, not fiscal policy.

32. 2000 -

33. 2001 -

Basically, the procedures for the choice of the winner of the economics price are the same as for the original Nobel prices. Every October a form, to be filled in with suggested candidates, is sent to professors at about 75 departments of economics all over the world and the selection of departments varies from year to year. A typical feature of the proposals is that the suggestions tend to be concentrated on well-known and highly respected economists, in particular on scholars in the field of "central" economic theory as traditionally understood. Economists who have been involved in controversies over economic policy issues are often also suggested. By contrast, economists who have made important and highly original contributions in specialized fields of economic analysis are not frequently proposed. The awards that have been made obviously reflect some characteristic features of economic analysis during the last half century, in particular during the post – World War II period. Clearly, the award reflect the dominant role of the United States in economic research in the post-World War II period. Turning to the context of the price contributions, the strong emphasis on deductive rather than inductive methods in economic analysis shows up strongly. As compared to most natural sciences, economic research is characterize by a rather weak interaction between induction and deduction. The increased role of formalization and the increased use of mathematics are also strongly reflected in the awards. However, it is important to note that formalization and sophisticated quantitative methods have been recognized by the price awarding authority only

in so far as they have been judged to have yielded a rich context of economics and hence, contributed to new important insights about economic behavior and mechanisms. Again, due partly to the existing backlog of old contributions, and also to a tendency of the price awarding authorities to "play safe", new trends in economic research during the last one or two decades do not yet show up much in the awards made so far. Most likely they will do so during the coming years, when the emphasis probably will shift from "established" to new research results, and perhaps also to younger laureates. Finally, we may wish to ask how has the selection committee viewed the award as a chance to influence the direction of new research in economics? The answer is not positive, in the sense that the committee has tried to ensure "catholicity" and " pluralism" of outlook in its decisions about awards, and to emphasize the multidimensional nature of economic research. However, this eclectic approach could be regarded as a way to influence views about fruitful research by recognizing research fields and methods that are not being in favor , for the time, because of the band wagon effects connected with new fashions. Thus, it may be argued that price awarding authority also demonstrated implicitly that there are many different ways to advance a science like economics: rigorous deductive theorizing, whether by way of verbal, geometric or mathematical techniques; the development and application of new concepts, classification and methods of analysis; rigorous empirical testing of existing hypotheses, as well as less formalized confrontation of various hypotheses with empirical fact; or "simply" profound observation and non formalized theorizing about economic behavior and mechanisms.

6.0 **CONCLUSION:**

Despite the ongoing controversies in the field of economics today, New Millennium economists are far more comfortable with what they do after the changes in the structure and content of economics over the last half century. The better feeling abut being overeducated has occurred because of the change in the structure of economics. This view that economists were overeducated followed in large part from the approach to economic training in the 1990s, in which all students went through the same extensive training and ended up using relatively little of it in their later professional work. However, the new millennium economic training is much more individually focused, with the training of students concentrating on those aspects of knowledge more relevant for their proposed field. Rather than bounding after the unknowable and trying to deduce analytical models that hold for all times, economics has reduced its search to what it believes is knowable. Thus, new millennium economists search for patterns in data, try to find temporary models that fit the patterns, and study the changing nature of those patterns as institutions change. In other words, the underlying mathematical structure of models and computational techniques that economists will use in future, are much more complicated, but most economists will be trained to use these tools.

In conclusion, we may wish to ask the following questions: How did the world economy of today, with its vast differences in income levels and growth rates,

emerge from the world of two centuries ago, in which the richest and the poorest societies had incomes differing by perhaps a factor of two, and in which no society had ever enjoyed sustained growth in living standards? This among other questions demands explanation from the economists of the 21st century and beyond. It is our belief that this article will provide insights to these types of economic puzzles.

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