Structural Changes in Economics during the Last Fifty Years*

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1.0. The pre-classical economics: The pre-classical economics, if this term can be used to denote an enquiry regarding the system of livelihood of the people and forces determining their prosperity that existed before the rise of science and industrial revolution, can be summarized in terms of the "**Closed system-Caste-Power-Religion-Custom**" nexus. The economic life of the commoners/laity was controlled by the nobility (or aristocracy) or the clergy (religious heads); tradition-bound it went in a perpetual cycle without much development for a very long time. This circularity gave rise to 'caste' – *tying of the type of livelihood to birth in a social group* (see Knox on the medieval society in the western civilization). The rise of science and the industrial revolution overthrew the power of the state as well as the priests and destabilized the age-old caste system. Power went into the hands of the industrialists and the formation of 'economic class' began. These developments gave rise to economics as a new scientific enquiry.

The subsequent development of economics as a structure of thought can be phased into (i) the classical synthesis (of pre-classical, Mercantilist and Physiocratic doctrines), (ii) The Marxian antithesis, (iii) the neoclassical reconstruction and orthodoxy, (iv) the "old" institutionalism, (v) the Keynesian antithesis, (vi) Keynesian economics -in the sense of Axel Leijonhufvud (1968), (vii) the Post-World War-II developments, (viii) the decline of neoclassicism, (ix) modern heterodoxy, and (x) the strands of modern economics.

Modern heterodoxy (against the mainstream or orthodox neoclassicism) and modern economics have several (hitherto un-synthesized) currents: (i) behavioral economics, (ii) experimental economics, (iii) evolutionary economics, (iv) agent-based economics, (v) new Institutional economics, (vi) post-autistic economics, and (vii) ecological economics. In what follows, a synoptic account of these currents is presented.

2.0. Classical economics: Classical economics is widely regarded as the first modern school of economic thought. Its major developers include Adam Smith, David Ricardo, Thomas Malthus and John Stuart Mill. Sometimes the definition of classical economics is expanded to include William Petty, Johann Heinrich von Thünen, and possibly Karl Marx.

Adam Smith's The Wealth of Nations in 1776 is usually considered to mark the beginning of classical economics. The school was active into the mid 19th century and was followed by neoclassical economics in Britain beginning around 1870.

Classical economists attempted and partially succeeded to explain economic growth and development. They produced their "magnificent dynamics" during a period in which capitalism was emerging from a past feudal society and in which the industrial revolution was leading to vast changes in society. These changes also raised the question of how a society could be organized around a system in which every individual sought his or her own (monetary) gain.

Classical economists reoriented economics away from an analysis of the *"ruler's personal interests"* to a *"class-based interest"*. Physiocrat Francois Quesnay and Adam Smith, for example, identified the wealth of a nation with the yearly national income, instead of the king's treasury. Smith saw this income as produced by labor applied to land and capital equipment. Once land and capital equipment are appropriated by individuals, the national income is divided up between laborers, landlords, and capitalists in the form of wages, rent, and interest.

2.1. Value and distribution theory: Classical economists developed a theory of value, or price, to investigate economic dynamics. William Petty introduced a fundamental distinction between market price and natural price to facilitate the portrayal of regularities in prices. Market prices are jostled by many transient influences that are difficult to theorize about at any abstract level. Natural prices, according to Petty, Smith, and Ricardo, for example, capture systematic and persistent forces operating at a point in time. Market prices always tend toward natural prices in a process that Smith described as somewhat similar to gravitational attraction. The value of a product was thought to depend on the costs involved in producing that product. The explanation of costs in Classical economics was simultaneously an explanation of distribution. A landlord received rent, workers received wages, and a capitalist tenant farmer received profits on their investment.

The theory of what determined natural prices varied within the Classical school. Petty tried to develop a par between land and labor and had what might be called a land-and-labor theory of value. Smith confined the labor theory of value to a mythical pre-capitalist past. He stated that natural prices were the sum of natural rates of wages, profits (including interest on capital and wages of superintendence) and rent. Ricardo also had what might be described as a cost of production theory of value. He criticized Smith for describing rent as price-determining, instead of price-determined, and saw the labor theory of value as a good approximation.

Some historians of economic thought, in particular, Sraffian economists, see the classical theory of prices as determined from three givens: (i) The level of outputs at the level of Smith's "effectual demand", (ii) technology, and (iii) wages.

From these givens, one can rigorously derive a theory of value. But neither Ricardo nor Marx, the most rigorous investigators of the theory of value during the Classical period, developed this theory fully. Those who reconstruct the theory of value in this manner see the determinants of natural prices as being explained by the Classical economists from within the theory of economics, albeit at a lower level of abstraction. For example, the theory of wages was closely connected to the theory of population. The Classical economists took the theory of the determinants of the level and growth of population as part of Political Economy. Since then, the theory of population has been seen as part of some other discipline than economics. In contrast to the Classical theory, the determinants of the neoclassical theory of value are the supply and

demand. In the neoclassical theory tastes /preferences, technology, and endowments are seen as exogenous to the economic system.

Classical economics tended to stress the benefits of trade. Its theory of value was largely displaced by marginalist schools of thought which sees "use value" as deriving from the marginal utility that consumers finds in a good, and "exchange value" (i.e. natural price) as determined by the marginal opportunity - or disutility - cost of the inputs that make up the product. Ironically, considering the attachment of many classical economists to the free market, the largest school of economic thought that still adheres to classical form is the Marxian school.

2.2. Monetary theory: British classical economists in the 19th century had a well-developed controversy between the Banking and the Currency schools. This parallels recent debates between proponents of the theory of endogeneous money, such as Nicholas Kaldor, and monetarists, such as Milton Friedman. Monetarists and members of the currency school argued that banks can and should control the supply of money. According to their theories, inflation is caused by banks issuing an excessive supply of money. According to proponents of the theory of endogeneous money, the supply of money automatically adjusts to the demand, and banks can only control the terms (e.g., the rate of interest) on which loans are made.

3.0. Neoclassical economics: Neoclassical economics is a term variously used for approaches to economics focusing on the determination of prices, outputs, and income distributions in markets through supply and demand, often as mediated through a hypothesized maximization of income-constrained utility by individuals and of cost-constrained profits of firms employing available information and factors of production, in accordance with *rational choice theory*. Mainstream economics is largely neoclassical in its assumptions, at least at the microeconomic level. There have been many critiques of neoclassical economics, often incorporated into newer versions of neoclassical theory as human awareness of economic criteria change. Neoclassical economics is often called “the marginalist school”, although the Austrian School founded by Carl Menger represents a distinct marginalist school.

The term was originally introduced by Thorstein Veblen in 1900, in his *Preconceptions of Economic Science*, to distinguish marginalists in the tradition of Alfred Marshall from those in the Austrian School. It was later used by George Stigler and John Hicks (who presumed significant disputes amongst marginalist schools had been largely resolved) to include the work of Carl Menger, William Stanley Jevons, and John Bates Clark. Today it is often used to refer to mainstream economics and the Chicago school, although it has been used as an umbrella term encompassing a number of mainly defunct schools of thought, notably excluding institutional economics, various historical schools of economics, and Marxian economics, in addition to various other heterodox economics.

Neoclassical economics is the singular element several schools of thought in economics address. There is not a complete agreement on what is meant by neoclassical economics, and the result is a wide range of neoclassical approaches to various problem areas and domains -- ranging from neoclassical theories of labor to neoclassical theories of demographic changes. As expressed by E. Roy Weintraub, neoclassical economics rests on three assumptions, although certain branches of neoclassical theory may have different approaches: (a). *people have rational preferences among outcomes that can be identified and associated with a value,* (b). *individuals*

maximize utility and firms maximize profits, (c). *people act independently on the basis of full and relevant information*. From these three assumptions, neoclassical economists have built a structure to understand the allocation of scarce resources among alternative ends -- in fact understanding such allocation is often considered the definition of economics to neoclassical theorists. Here's how William Stanley Jevons presented "the problem of Economics".

"**Given**: *a certain population, with various needs and powers of production, in possession of certain lands and other sources of material.* **Required**: *the mode of employing their labour which will maximize the utility of their produce*."

From the basic assumptions of neoclassical economics comes a wide range of theories about various areas of economic activity. For example, profit maximization lies behind the neoclassical theory of the firm, while the derivation of demand curves leads to an understanding of consumer goods, and the supply curve allows an analysis of the factors of production. Utility maximization is the source for the neoclassical theory of consumption, the derivation of demand curves for consumer goods, and the derivation of labor supply curves and reservation demand. Market supply and demand are aggregated across firms and individuals. Their interactions determine equilibrium output and price. The market supply and demand for each factor of production is derived analogously to those for market final output to determine equilibrium income and the income distribution. Factor demand incorporates the marginal-productivity relationship of that factor in the output market.

Neoclassical economics emphasizes equilibria, where equilibria are the solutions of agent maximization problems. Regularities in economies are explained by methodological individualism, the position that economic phenomena can be explained by aggregating over the behavior of agents. The emphasis is on microeconomics. Institutions, which might be considered as prior to and conditioning individual behavior, are de-emphasized. Economic subjectivism accompanies these emphases.

3.1. Connections with classical economics: Classical economics, developed in the 18th and 19th centuries, included a value theory and distribution theory. The value of a product was thought to depend on the costs involved in producing that product. The explanation of costs in Classical economics was simultaneously an explanation of distribution. A landlord received rent, workers received wages, and a capitalist tenant farmer received profits on their investment. This classic approach included the work of Adam Smith and David Ricardo.

However, some economists gradually began emphasizing the perceived value of a goods to the consumer. They proposed a theory that the value of a product was to be explained with differences in "utility." This is called Utilitarianism and is associated with philosopher and economic thinker John Stuart Mill.

The third step from political economy to economics was the introduction of the "marginal theory of value" or marginalism. Marginal value means that economic actors make decisions based on the "margins". This differs from the aggregate decision making of classical political economy in that it explains how vital goods such as water can be cheap, while luxuries can be expensive.

Neoclassical economics is conventionally dated from William Stanley Jevons's Theory of Political Economy (1871), Carl Menger's Principles of Economics (1871), and Leon Walras's Elements of Pure Economics (1874 – 1877). These three economists have been said to have promulgated the marginal utility revolution, or Neoclassical Revolution. Historians of economics and economists have debated:

(a). Whether utility or marginalism was more essential to this revolution (whether the noun or the adjective in the phrase "marginal utility" is more important)
(b). Whether there was a revolutionary change of thought or merely a gradual development and change of emphasis from their predecessors
(c). Whether grouping these economists together disguises differences more important than their similarities.

In particular, Walras was more interested in the interaction of markets than in explaining the individual psyche through a hedonistic psychology. Jevons saw his economics as an application and development of Jeremy Bentham's utilitarianism and never had a fully developed general equilibrium theory. Menger emphasized disequilibrium and the discrete. Menger had a philosophical objection to the use of mathematics in economics, while the other two modeled their theories after 19th century mechanics.

Alfred Marshall's textbook, Principles of Economics (1890), was the dominant textbook in England a generation later. Marshall thought classical economics attempted to explain prices by the cost of production alone and the Continental Neoclassicists went too far in correcting this imbalance by overemphasizing utility and demand. Marshall thought the question of whether supply or demand was more important was analogous to the pointless question of which blade of a scissors did the cutting.

Marshall explained prices by the intersection of supply and demand curves. The introduction of different market "periods" was an important innovation of Marshall:

Market period: The goods produced for sale on the market are taken as given data, e.g. in a fish market. Prices quickly adjust to clear markets.
Short period: Industrial capacity is taken as given. The level of output, the level of employment, the inputs of raw materials, and prices fluctuate to equate marginal cost and marginal revenue, where profits are maximized. Economic rents exist in short period equilibrium for fixed factors, and the rate of profit is not equated across sectors.
Long period: The stock of capital goods, such as factories and machines, is not taken as given. Profit-maximizing equilibria determine both industrial capacity and the level at which it is operated.
Very long period: Technology, population trends, habits and customs are not taken as given, but allowed to vary in very long period models.

Marshall took supply and demand as stable functions and extended supply and demand explanations of prices to all runs. He argued supply was easier to vary in longer runs, and thus became a more important determinate of price in the very long run.

3.2. Controversy on relationship between classical and neoclassical economics: Sraffians, who emphasize the discontinuity thesis, see classical economics as extending from Willam Petty's work in the 17th century to the break-up of the Ricardian system around 1830. The period between 1830 and the 1870s would then be dominated by "vulgar political economy", as Karl Marx characterized it. Sraffians argue that: the wages fund theory; Senior's abstinence theory of interest, which puts the return to capital on the same level as returns to land and labor; the explanation of equilibrium prices by well-behaved supply and demand functions; and Say's law, are not necessary or essential elements of the classical theory of value and distribution. Perhaps Schumpeter's view that John Stuart Mill put forth a half-way house between classical and neoclassical economics is consistent with this view.

Sraffians generally see Marx as having rediscovered and restated the logic of classical economics, albeit for his own purposes. Others, such as Schumpeter, think of Marx as a follower of Ricardo. Even Samuel Hollander has recently explained that there is a textual basis in the classical economists for Marx's reading, although he does argue that it is an extremely narrow set of texts.

The first position is that neoclassical economics is essentially continuous with classical economics. To scholars promoting this view, there is no hard and fast line between classical and neoclassical economics. There may be shifts of emphasis, such as between the long run and the short run and between supply and demand, but the neoclassical concepts are to be found confused or in embryo in classical economics. To these economists, there is only one theory of value and distribution. Alfred Marshall is a well-known promoter of this view. Samuel Hollander is probably its best current proponent.

A second position sees two threads simultaneously being developed in classical economics. In this view, neoclassical economics is a development of certain exoteric (popular) views in Adam Smith. Ricardo was a sport, developing certain esoteric (known by only the select) views in Adam Smith. This view can be found in W. Stanley Jevons, who referred to Ricardo as something like "that able, but wrong-headed man" who put economics on the "wrong track". One can also find this view in Maurice Dobb's *Theories of Value and Distribution Since Adam Smith: Ideology and Economic Theory (1973)*, as well as in Karl Marx's *Theories of Surplus Value*.

The above does not exhaust the possibilities. John Maynard Keynes thought of classical economics as starting with Ricardo and being ended by the publication of Keynes' General Theory of Employment Interest and Money. The defining criterion of classical economics, on this view, is Say's law.

One difficulty in these debates is that the participants are frequently arguing about whether there is a non-neoclassical theories that should be reconstructed and applied today to describe capitalist economies. Some see classical economics as of antiquarian interest.

3.3. Further developments: An important change in neoclassical economics occurred around 1933. Joan Robinson and Edward H. Chamberlin, with the near simultaneous publication of their respective books, The Economics of Imperfect Competition (1933) and The Theory of Monopolistic Competition (1933), introduced models of imperfect competition. Theories of

market forms and industrial organization grew out of this work. They also emphasized certain tools, such as the marginal revenue curve.

Joan Robinson's work on imperfect competition, at least, was a response to certain problems of Marshallian partial equilibrium theory highlighted by Piero Sraffa. Anglo-American economists also responded to these problems by turning towards general equilibrium theory, developed on the European continent by Walras and Vilfredo Pareto. Hicks's Value and Capital (1939) was influential in introducing his English-speaking colleagues to these traditions. He, in turn, was influenced by the Austrian School economist Friedrich Hayek's move to the London School of Economics, where Hicks then studied.

These developments were accompanied by the introduction of new tools, such as indifference curves and the theory of ordinal utility. The level of mathematical sophistication of neoclassical economics increased. Paul Samuelson's Foundations of Economic Analysis (1947) contributed to this increase in formal rigor.

The interwar period in American economics has been argued to have been pluralistic, with neoclassical economics and institutionalism competing for allegiance. Frank Knight, an early Chicago school economist attempted to combine both schools. But this increase in mathematics was accompanied by greater dominance of neoclassical economics in Anglo-American universities after World War II.

Hicks' book, Value and Capital had two main parts. The second, which was arguably not immediately influential, presented a model of temporary equilibrium. Hicks was influenced directly by Hayek's notion of intertemporal coordination and paralleled by earlier work by Lindhal. This was part of an abandonment of disaggregated long run models. This trend probably reached its culmination with the Arrow-Debreu model of intertemporal equilibrium. The Arrow-Debreu model has canonical presentations in Gerard Debreu's Theory of Value (1959) and in Arrow and Hahn.

Many of these developments were against the backdrop of improvements in both econometrics, that is the ability to measure prices and changes in goods and services, as well as their aggregate quantities, and in the creation of macroeconomics, or the study of whole economies. The attempt to combine neo-classical microeconomics and Keynesian macroeconomics would lead to the neoclassical synthesis which has been the dominant paradigm of economic reasoning in English-speaking countries since the 1950s. Hicks and Samuelson were for example instrumental in mainstreaming Keynesian economics.

Macroeconomics influenced the neoclassical synthesis from the other direction, undermining foundations of classical economic theory such as Say's Law, and assumptions about political economy such as the necessity for a hard-money standard. These developments are reflected in neoclassical theory by the search for the occurrence in markets of the equilibrium conditions of Pareto optimality and self-sustainability.

3.4. Criticisms: Neoclassical economics is sometimes criticized for having a normative bias. In this view, it does not focus on explaining actual economies, but instead on describing a "utopia"

in which Pareto optimality applies. Key assumptions of neoclassical economics which are criticised as unrealistic include:

(a). The assumption that individuals act rationally may be viewed as ignoring important aspects of human behavior. Many see the "economic man" as being demonstrably different from a real man on the real earth. The assumption of rational expectations which has been introduced in some more modern neo-classical models (sometimes also called new classical) can also be criticized on the grounds of realism.

(b). Problems with making the neoclassical general equilibrium theory compatible with an economy that develops over time and includes capital goods. This was explored in a major debate in the 1960s—the "Cambridge capital controversy"—about the validity of neoclassical economics, with an emphasis on the economic growth, capital, aggregate theory, and the marginal productivity theory of distribution. There were also internal attempts by neoclassical economists to extend the Arrow-Debreu model to disequilibrium investigations of stability and uniqueness. However a result known as the *Sonnenschein-Mantel-Debreu theorem suggests that the assumptions that must be made to insure that the equilibrium is stable and unique are quite restrictive*.

In the opinion of some, these developments have found fatal weaknesses in neoclassical economics. Economists, however, have continued to use highly mathematical models, and many equate neoclassical economics with economics, unqualified. Mathematical models include those in game theory (against atomistic individualism), linear programming (against marginalism), and econometrics (against deductionism) , many of which might be considered non-neoclassical. So economists often refer to what has evolved out of neoclassical economics as "mainstream economics". Critics of neoclassical economics are divided in those who think that highly mathematical method is inherently wrong and those who think that mathematical method is potentially good even if contemporary methods have problems.

The basic theory of a downward sloping aggregate demand curve is criticized for its allegedly strong assumptions.

In general, allegedly overly unrealistic assumptions are one of the most common criticisms towards neoclassical economics. For example, many theories assume perfect knowledge for market actors and the most common theory of finance markets assumes that debts are always paid back and that any actor can raise as much loan as he wants at any given point of time.

The basic theory of production in neoclassical economics is criticized for incorrect assumptions about the rationales of producers. According to the theory, increasing production costs are the reason for producers not to produce over a certain amount. Some empirical counter arguments claim that most producers are not making their production decisions in the light of increasing production costs. For example they often may have additional capacity that could be taken into use, if producing more was desirable.

Often at individual levels, variables such as supply and demand, which are independent, are (allegedly wrongly) assumed to be independent also at aggregate level. This criticism has been applied to many central theories of neoclassical economics.

The critique of the assumption of rationality is not confined to social theorists and ecologists. Many economists, even contemporaries, have criticized this vision of economic man. Thorstein Veblen put it most sardonically. Neoclassical economics assumes a person to be,

"a lightning calculator of pleasures and pains, who oscillates like a homogeneous globule of desire of happiness under the impulse of stimuli that shift about the area, but leave him intact."

Herbert Simon's theory of *bounded rationality* has probably been the most influential of the heterodox approaches. Is economic man a first approximation to a more realistic psychology, an approach only valid in some sphere of human lives, or a general methodological principle for economics? Early neoclassical economists often leaned toward the first two approaches, but the latter has become prevalent.

Neoclassical economics is also often seen as relying too heavily on complex mathematical models, such as those used in general equilibrium theory, without enough regard to whether these actually describe the real economy. Many see an attempt to model a system as complex as a modern economy by a mathematical model as unrealistic and doomed to failure. Famous answer to this criticism is Milton Friedman's claim that theories should be judged by their ability to predict events rather than by the realisticity of their assumptions. Naturally, critics claim that neoclassical economics (as well as other branches of economics) has not been very good at predicting events.

Critics of neoclassical models accuse it of copying of 19th century mechanics and the "clockwork" model of society which seems to justify elite privileges as arising "naturally" from the social order based on economic competitions. This is echoed by modern critics in the anti-globalization movement who often blame the neoclassical theory, as it has been applied by the IMF in particular, for inequities in global debt and trade relations. They assert it ignores the complexity of nature and of human creativity, and seeks mechanical ideas like equilibrium.

It is fair to say that many (but not all) of these criticisms can only be directed towards a subset of the neoclassical models (for example, there are many neoclassical models where unregulated markets fail to achieve Pareto-optimality and there has recently been an increased interest in modelling bounded rationality).

4.0. Heterodox economics: Heterodox economics refers to the approaches, or schools of economic thought, that are considered outside of mainstream or orthodox economics. Heterodox Economics is an umbrella term used to cover various separate unorthodox approaches, schools, or traditions. These include post Keynesianism, Technocratic, Old institutionalism, feminist, social, Marxian, Thermo-economics and Austrian economics, among others. These views may be contrasted with the framework used by the majority of economists, commonly referred to by its supporters as mainstream and by critics as orthodox. This framework consists of the neoclassical synthesis, which combines a neoclassical approach on microeconomics and Keynesian approach to macroeconomics, with varying degrees of emphasis.

It is difficult to define heterodox economics. The International Confederation of Associations for Pluralism in Economics (ICAPE) has prudently avoided defining its umbrella too specifically, choosing instead to define its mission as "promoting pluralism in economics." All strands of socialism are heterodox, but not all heterodox schools are socialist. A key challenge for "heterodoxy" is to define itself in ways that move beyond the rubric of "non-neoclassical" economics. In defining a common ground in the "critical commentary" some heterodox economists, such as Steve Cohn, have tried to do three things: (1) identify shared ideas that generate a pattern of heterodox critique across topics and chapters of introductory macro texts; (2) give special attention to ideas that link methodological differences to policy differences; and (3) characterize the common ground in ways that permit distinct paradigms to develop common differences with textbook economics in different ways.

The orthodox economics has also been alleged to be an apologia in defense of the market economy based on the institution of private property and individualism. The medieval economy was tradition bound and robust. The industrial revolution perforce threw this economy out of gear and a natural question arose if the new order would be stable and desirable. Stated differently, the new order gave rise to the six fundamental questions: (i) will the society organized on the principles of exchange stay composed or will it fall apart (the question of existence of equilibrium)?, (ii) will such an equilibrium be unique (a multiplicity of equilibria poses difficult and embarrassing questions)?, (iii) will such an equilibrium be robust (the question of stability of equilibrium)?, (iv) will such an economy (society) be efficient?, (v) will it grow or expand forever?, and (vi) will it be just? The classical economists, Adam Smith in particular, answered all these questions affirmatively using a characteristic methodology. However, Karl Marx challenged the entire structure of faith in the merits of the exchange economy and shattered all optimism regarding the said order. The neoclassicists, mostly using their own new (mathematical, marginalist, rationalistic, atomistic, hedonistic, etc) methodology set out to prove that answers to all those six questions were in affirmative. They restructured the faith in the said order. In so doing, they had to distance themselves from the reality and they did not mind doing so. This endeavour made neoclassical economics dogmatic and religious in nature. Leijonhufvud (1973) characterized neoclassical economics in the most sarcastic manner. Heterodox economics grew out of the disapproval of the said dogma.

4.1. Rationality: One of the most broadly accepted principles of neoclassical economics is the assumption of the "rationality of economic agents". Indeed, for a number of economists, the notion of rational maximizing behavior is taken to be synonymous with economic behavior. When some economists' studies do not embrace the rationality assumption, they are seen as placing the analyses outside the boundaries of the Neoclassical economics discipline. Neoclassical economics begins with the a priori assumptions that agents are "rational" and that they seek to "maximize their individual utility" (or profits) subject to environmental constraints. These assumptions provide the backbone for rational choice theory, and from this basis neoclassical economists derive the familiar supply and demand functions which, under certain conditions, will lead to a determinate market clearing equilibrium. Under even stricter conditions this equilibrium will be Pareto efficient.

Heterodox economics reject these fundamental assumptions on which most of neoclassical economics theory has been built. Up to 1980 heterodox economics could be defined as:

(a). Rejection of the atomistic individual conception in favor of a socially embedded individual conception;
(b). Emphasis on time as an irreversible historical process;
(c). Reasoning in terms of mutual influences between individuals and social structures.

Hence, while mainstream (neoclassical) economics may be defined in terms of the "**Closed system-Rationality-Individualism-Equilibrium**" nexus, heterodox economics may be defined in terms of a "**Open system-Institutions-History-pluralism-Social structure-Evolution**" nexus. Against these two, the classical economics may be defined in terms of "**Open system-Class-Value-Distribution-Development**" nexus while the pre-classical economics can be defined in terms of "**Closed system-Caste-Power-Religion-Custom**" nexus.

From 1980 (or thereabouts) significant changes begin to occur in economics; a number of new research programs began, in various ways, to be recognized by the mainstream economics. These include behavioral economics, complexity economics, evolutionary economics, experimental economics, neuro-economics, and others. As a consequence, some heterodox economists proposed that the definition of heterodox economics has to be adapted to this new, more complex reality.

Heterodox economics post-1980 is a complex structure, being composed out of two broadly different kinds of heterodox work, each internally differentiated with a number of research programs having different historical origins and orientations: **the traditional left heterodoxy** familiar to most and **the 'new heterodoxy' resulting from other science imports**.

4.2. Rejection of neoclassical economics: There is no single "heterodox economic theory"; there are many different "heterodox theories" in existence. "What they all share, however, is a rejection of the neoclassical orthodoxy as representing the appropriate tool for understanding the workings of economic and social life. The reasons for this rejection may vary.

Reasons for the rejection of neoclassical economics: The neoclassical framework has often been rejected on the arguments such as: (a). that neoclassical theory is appropriate as a tool only under certain limited conditions, where there is "perfect" or "near-perfect" competition; (b) the Austrian School in particular considers neoclassical theory relevant for conditions of equilibrium, (c). that it is useless as a tool for understanding economic and social life, (d). that all theories are valid so long as they are internally consistent, (e). that neoclassical theory is a form of ideology or religion, which is grounded in unscientific concepts. Neoclassical economic theory is grounded in a particular conception of human psychology, agency or decision-making. It is assumed that all human beings make economic decisions so as to maximize pleasure or utility. Some heterodox theories reject this basic assumption of neoclassical theory, arguing for alternative understandings of how economic decisions are made and/or how human psychology works. It is possible to accept the notion that humans are pleasure seeking machines, yet reject the idea that economic decisions are governed by such pleasure seeking. Human beings may, for example, be unable to make choices consistent with pleasure maximization due to social constraints and/or coercion. Humans may also be unable to correctly assess the choice points that are most likely to lead to maximum pleasure, even if they are unconstrained (except in budgetary terms) in making such choices. And it is also possible that the notion of pleasure

seeking is itself a meaningless assumption because it is either impossible to test or too general to refute. Economic theories that reject the basic assumption of economic decisions as the outcome of pleasure maximization are heterodox.

4.3. Most recent developments: Over the past two decades, the intellectual agendas of heterodox economists have taken a decidedly pluralist turn. Leading heterodox thinkers have moved beyond the established paradigms of Austrian, Feminist, Institutional-Evolutionary, Marxian, Post Keynesian, Radical, Social, and Sraffian economics—opening up new lines of analysis, criticism, and dialogue among dissenting schools of thought. This cross-fertilization of ideas is creating a new generation of scholarship in which novel combinations of heterodox ideas are being brought to bear on important contemporary and historical problems, such as socially-grounded reconstructions of the individual in economic theory; the goals and tools of economic measurement and professional ethics; the complexities of policymaking in today's global political economy; and innovative connections among formerly separate theoretical traditions (Marxian, Austrian, feminist, ecological, Sraffian, institutionalist, and post-Keynesian).

David Colander, an advocate of complexity economics, argues that the ideas of heterodox economists are now being discussed in the mainstream without mention of the heterodox economists, because the tools to analyze institutions, uncertainty, and other factors have now been developed by the mainstream. He suggests that heterodox economists should embrace rigorous mathematics and attempt to work from within the mainstream, rather than treating it as an enemy.

4.4. Energy accounting economics and balance: An energy balance can be used to track energy through a system, and is a very useful tool for determining resource use and environmental impacts. The idea is to use the First and Second laws of thermodynamics to determine how much energy is needed at each point in the system, and in what form that energy is. An Energy Accounting system keeps track of energy in, energy out, and non-useful energy versus work done, and transformations within the system.

Physical scientists and biologists were the first individuals to use energy flows to explain social and economic development. Joseph Henry, an American physicist and first secretary of the Smithsonian Institution, remarked that the "fundamental principle of political economy is that the physical labor of man can only be ameliorated by...the transformation of matter from a crude state to a artificial condition...by expending what is called power or energy."

Energy Accounting which developed as a concept in the 1930's, is the hypothetical system of distribution, proposed by Technocracy Incorporated in the Technocracy Study Course, which would record the energy used to produce and distribute goods and services consumed by citizens in a Technate instead of relying on a system of using money. Scientists have written and speculated on different aspects of energy accounting. Many variations of energy accounting are in use now, as this issue relates to current (price system) economics directly, as well as projected models in possible Non-market economics systems.

4.5. Other perspectives: Research is also being done in the multidisciplinary field of cognitive science on individual decision making, information as a general phenomenon, distributed cognition and their implications on economic dynamicity. Some schools in the social sciences

aim to promote certain perspectives: classical and modern political economy; economic history; economic sociology and anthropology; gender and racial issues in economics; economic ethics and social justice; development studies; and so on.

5.0. Behavioural economics: Behavioral economics applies scientific research on human and social cognitive and emotional biases to better understand economic decisions and how they affect market prices, returns and the allocation of resources. It is primarily concerned with the rationality, or lack thereof, of economic agents. Behavioral models typically integrate insights from psychology with neo-classical economic theory.

During the classical period, economics had a close link with psychology. For example, Adam Smith wrote The Theory of Moral Sentiments, an important text describing psychological principles of individual behavior; and Jeremy Bentham wrote extensively on the psychological underpinnings of utility. Economists began to distance themselves from psychology during the development of neo-classical economics as they sought to reshape the discipline as a natural science, with explanations of economic behavior deduced from assumptions about the nature of economic agents. The concept of homo economicus was developed, and the psychology of this entity was fundamentally rational. Nevertheless, psychological explanations continued to inform the analysis of many important figures in the development of neo-classical economics such as Francis Edgeworth, Vilfredo Pareto, Irving Fisher and John Maynard Keynes.

Although psychology had nearly disappeared from economic discussions by the mid 20th century, it, somehow, managed to stage a resurgence, and certain factors were responsible for this resurgence in the continued development of behavioral economics. Expected utility and discounted utility models began to gain wide acceptance, generating testable hypotheses about decision making under uncertainty and intertemporal consumption respectively. Soon a number of observed and repeatable anomalies challenged those hypotheses. Furthermore, during the 1960s cognitive psychology had begun to shed more light on the brain as an information processing device (in contrast to behaviorist models). Psychologists in this field such as Ward Edwards, Amos Tversky and Daniel Kahneman began to compare their cognitive models of decision making under risk and uncertainty to economic models of rational behavior. In Mathematical psychology, there is a longstanding interest in the transitivity of preference and what kind of measurement scale utility constitutes.

An important paper in the development of the behavioral finance and economics fields was written by Kahneman and Tversky in 1979. This paper, 'Prospect theory: An Analysis of Decision Under Risk', used cognitive psychological techniques to explain a number of documented divergences of economic decision making from neo-classical theory. Over time many other psychological effects have been incorporated into behavioral finance, such as overconfidence and the effects of limited attention. Further milestones in the development of the field include a well attended and diverse conference at the University of Chicago, a special 1997 edition of the Quarterly Journal of Economics ('In Memory of Amos Tversky') devoted to the topic of behavioral economics and the award of the Nobel prize to Daniel Kahneman in 2002 "for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty".

Prospect theory is an example of generalized expected utility theory. Although not commonly included in discussions of the field of behavioral economics, generalized expected utility theory is similarly motivated by concerns about the descriptive inaccuracy of expected utility theory.

Behavioral economics has also been applied to problems of intertemporal choice. The most prominent idea is that of hyperbolic discounting, proposed by George Ainslie (1975), in which a high rate of discount is used between the present and the near future, and a lower rate between the near future and the far future. This pattern of discounting is dynamically inconsistent (or time-inconsistent), and therefore inconsistent with some models of rational choice, since the rate of discount between time t and t+1 will be low at time t-1, when t is the near future, but high at time t when t is the present and time t+1 the near future. As part of the discussion of hypberbolic discounting, has been animal and human work on Melioration theory and Matching Law of Richard Herrnstein. They suggest that behavior is not based on expected utility rather it is based on previous reinforcement experience.

5.1. Methodology: At the outset behavioral economics and finance theories had been developed almost exclusively from experimental observations and survey responses, although in more recent times real world data have taken a more prominent position. Functional magnetic resonance imaging fMRI has complemented this effort through its use in determining which areas of the brain are active during various steps of economic decision making. Experiments simulating market situations such as stock market trading and auctions are seen as particularly useful as they can be used to isolate the effect of a particular bias upon behavior; observed market behavior can typically be explained in a number of ways, carefully designed experiments can help narrow the range of plausible explanations. Experiments are designed to be incentive-compatible, with binding transactions involving real money being the "norm".

5.2. Key observations: There are three main themes in behavioral finance and economics:

Heuristics: People often make decisions based on approximate rules of thumb, not strictly rational analysis. See also cognitive biases and bounded rationality.
Framing: The way a problem or decision is presented to the decision maker will affect his action.
Market inefficiencies: There are explanations for observed market outcomes that are contrary to rational expectations and market efficiency. These include mis-pricings, non-rational decision making, and return anomalies. Richard Thaler, in particular, has described specific market anomalies from a behavioral perspective.

Recently, Barberis, Shleifer, and Vishny as well as Daniel, Hirshleifer, and Subrahmanyam have built models based on extrapolation (seeing patterns in random sequences) and overconfidence to explain security market over- and underreactions, though such models have not been used in the money management industry. These models assume that errors or biases are correlated across agents so that they do not cancel out in aggregate. This would be the case if a large fraction of agents look at the same signal (such as the advice of an analyst) or have a common bias.

More generally, cognitive biases may also have strong anomalous effects in the aggregate if there is a social contamination with a strong emotional content (collective greed or fear), leading to more widespread phenomena such as herding and groupthink. Behavioral finance

and economics rests as much on social psychology within large groups as on individual psychology. However, some behavioral models explicitly demonstrate that a small but significant anomalous group can also have market-wide effects.

5.3. Critical conclusions of behavioral economics: Critics of behavioral economics typically stress the rationality of economic agents. They contend that experimentally observed behavior is inapplicable to market situations, as learning opportunities and competition will ensure at least a close approximation of rational behavior.

Others note that cognitive theories, such as prospect theory, are models of decision making, not generalized economic behavior, and are only applicable to the sort of once-off decision problems presented to experiment participants or survey respondents.

Traditional economists are also skeptical of the experimental and survey based techniques which are used extensively in behavioral economics. Economists typically stress revealed preferences over stated preferences (from surveys) in the determination of economic value. Experiments and surveys must be designed carefully to avoid systemic biases, strategic behavior and lack of incentive compatibility, and many economists are distrustful of results obtained in this manner due to the difficulty of eliminating these problems.

Some behavioural economists dismiss these criticisms, claiming that results are typically reproduced in various situations and countries and can lead to good theoretical insight. Behavioral economists have also incorporated these criticisms by focusing on field studies rather than lab experiments. Some economists look at this split as a fundamental schism between experimental economics and behavioral economics, but prominent behavioral and experimental economists tend to overlap techniques and approaches in answering common questions. For example, many prominent behavioral economists are actively investigating neuro-economics, which is entirely experimental and cannot be verified in the field.

Other proponents of behavioral economics note that neoclassical models often fail to predict outcomes in real world contexts. Behavioral insights can be used to update neoclassical equations, and behavioral economists note that these revised models not only reach the same correct predictions as the traditional models, but also correctly predict some outcomes where the traditional models failed.

6.0. Experimental economics: Experimental economics is the application of the laboratory method to test the validity of various economic theories and to test bed new market mechanisms. Using cash-motivated subjects, economic experiments create real-world incentives to help us better understand why markets and other exchange systems work the way they do. Experiments may be conducted in laboratory settings or in the field. The history and methodology of experimental economics was summarized by Vernon Smith:

"Historically, the method and subject matter of economics have presupposed that it was a non-experimental (or 'field observational') science more like astronomy or meteorology than physics or chemistry. Based on general, introspectively 'plausible', assumptions about human preferences, and about the cost and technology based supply response of producers, economists have sought to understand the functioning of economies, using observations

generated by economic outcomes realized over time. The data of the astronomer is of this same type, but it would be wrong to conclude that astronomy and economics are methodologically equivalent. There are two important differences between astronomy and economics which help to illuminate some of the methodological problems of economics. First, based upon parallelism (maintained hypothesis that the same physical laws hold everywhere), astronomy draws on all the relevant theory from classical mechanics and particle physics -- theory which has evolved under rigorous laboratory tests. Traditionally, economists have not had an analogous body of tested behavioural principles that have survived controlled experimental tests, and which can be assumed to apply with insignificant error to the microeconomic behaviour that underpins the observable operations of the economy. Analogously, one might have supposed that there would have arisen an important area of common interest between economics and, say, experimental psychology, similar to that between astronomy and physics, but this has only started to develop in recent years."

6.1. Experimental topics: Economics experiments can be loosely classified into the following topics: Markets, Games, Decision making, Bargaining, Auctions, Coordination, Social Preferences, Learning, Matching, and Field Experiments.

6.2. Coordination games: Coordination games are games with multiple equilibria, often Pareto ranked. There are two general sets of questions that experimental economists typically ask when examining such games: (1) Can laboratory subjects coordinate, or learn to coordinate, on one of multiple equilibria, and if so are there general principles that can help predict which equilibrium is likely to be chosen? (2) Can laboratory subjects coordinate, or learn to coordinate, on the Pareto best equilibrium and if not, are there conditions or mechanisms which would help subjects coordinate on the Pareto best equilibrium? Deductive selection principles are those that allow predictions based on the properties of the game alone. Inductive selection principles are those that allow predictions based on characterizations of dynamics.

6.3. Learning experiments: In games of two players or more, the subjects often form beliefs about what actions the other subjects are taking and these beliefs are updated over time. This is known as belief learning. Subjects also tend to make the same decisions that have rewarded them with high payoffs in the past. This is known as reinforcement learning.

Until the 1990s, simple adaptive models, such as Cournot best response or Fictitious play, were generally used. In the mid-1990s, Alvin Roth and Ido Erev demonstrated that reinforcement learning can make useful predictions in experimental games. In 1999, Colin Camerer and Teck Ho introduced Experience Weighted Attraction, known as EWA, a general model that incorporated reinforcement and belief learning, and shows that fictitious play is mathematically equivalent to generalized reinforcement, provided weights are placed on past history.

Criticisms of EWA include overfitting due to many parameters, lack of generality over games, and the possibility that the interpretation of EWA parameters may be difficult. Overfitting is addressed by estimating parameters on some of the experimental periods or experimental subjects and forecasting behavior in the remaining sample (if models are overfitting, these out-of-sample validation forecasts will be much less accurate than in-sample fits, which they generally are not). Generality in games is addressed by replacing fixed parameters with "self-

tuning" functions of experience, allowing pseudo-parameters to change over the course of a game and to also vary systematically across games.

Modern experimental economists have done much notable work recently. Roberto Weber has raised issues of learning without feedback. David Cooper and John Kagel have investigated types of learning over similar strategies. Ido Erev and Greg Barron have looked at learning in cognitive strategies. Dale Stahl has characterized learning over decision making rules. Charles A. Holt has studied logit learning in different kinds of games, including games with multiple equilibria. Wilfred Amaldoss has looked at interesting applications of EWA in marketing. Amnon Rapoport, Jim Parco and Ryan Murphy have investigated reinforcement-based adaptive learning models in one of the most celebrated paradoxes in game theory known as the centipede game.

6.4. Market games: Vernon Smith, formerly of the University of Arizona and now at the Interdisciplinary Center for Economic Science at George Mason University conducted pioneering economics experiments on the convergence of prices and quantities to their theoretical competitive equilibrium values in experimental markets. Smith studied the behavior of "buyers" and "sellers", who are told how much they "value" a fictitious commodity, and then are asked to competitively "bid" or "ask" on these commodities following the rules of various real world market institutions, such as the Double auction (both sides can bid) used in many stock exchanges, as well the English auction and the Dutch auction (see Auctions). Smith found that in some forms of centralized trading, prices and quantities traded in such markets converge on the values that would be predicted by the economic theory of perfect competition, despite the conditions not meeting many of the assumptions of perfect competition (large numbers, perfect information).

Over the years, Smith pioneered -along with other collaborators- the use of controlled laboratory experiments in economics, and established it as a legitimate tool in economics and other related fields. Charles Plott of the California Institute of Technology collaborated with Smith in the 1970s and pioneered experiments in political science, as well as using experiments to inform economic design or engineering to inform policies. In 2002, Smith was awarded (jointly with Daniel Kahneman) the Bank of Sweden Prize in Economic Sciences "for having established laboratory experiments as a tool in empirical economic analysis, especially in the study of alternative market mechanisms".

6.5. Social preferences: The term "social preferences" refers to the concern (or lack thereof) that people have for each other's well-being, and it encompasses altruism, spitefulness, tastes for equality, and tastes for reciprocity. Experiments on social preferences generally study economic games including the dictator game, the ultimatum game, the trust game, the public goods game, and modifications to these canonical settings. As one example of results, ultimatum game experiments have shown that people are generally willing to sacrifice monetary rewards when offered low allocations, thus behaving inconsistently with simple models of self-interest. Economic experiments have measured how this deviation varies across cultures. (More market-oriented societies tend to have higher inequity aversion.)

6.6. Bounded rationality: Some models of human behavior in the social sciences assume that humans can be reasonably approximated or described as "rational" entities (see for example rational choice theory). Many economics models assume that people are hyperrational, and

would never do anything to violate their preferences. The concept of bounded rationality revises this assumption to account for the fact that perfectly rational decisions are often not feasible in practice due to the finite computational resources available for making them.

The term is thought to have been coined by Herbert Simon. In Models of My Life, Herbert Simon points out that most people are only partly rational, and are in fact emotional/irrational in the remaining part of their actions. In another work, he states "boundedly rational agents experience limits in formulating and solving complex problems and in processing (receiving, storing, retrieving, transmitting) information" (Williamson, p. 553, citing Simon). Simon describes a number of dimensions along which "classical" models of rationality can be made somewhat more realistic, while sticking within the vein of fairly rigorous formalization. These include: (i) limiting what sorts of utility functions there might be, (ii) recognizing the costs of gathering and processing information, (iii) the possibility of having a "vector" or "multi-valued" utility function.

Simon suggests that economic agents employ the use of heuristics to make decisions rather than a strict rigid rule of optimization. They do this because of the complexity of the situation, and their inability to process and compute the expected utility of every alternative action. Deliberation costs might be high and there are often other economic activities where similar decision making is required.

Daniel Kahneman proposes bounded rationality as a model to overcome some of the limitations of the rational-agent models in economic literature.

As decision makers have to make decisions about how and when to decide, Ariel Rubinstein proposed to model bounded rationality by explicitly specifying decision making procedures. This puts the study of decision procedures on the research agenda.

Gerd Gigerenzer argues that most decision theorists who have discussed bounded rationality have not really followed Simon's ideas about it. Rather, they have either considered how people's decisions might be made sub-optimal by the limitations of human rationality, or have constructed elaborate optimising models of how people might cope with their inability to optimize. Gigerenzer instead proposes to examine simple alternatives to a full rationality analysis as a mechanism for decision making, and he and his colleagues have shown that such simple heuristics frequently lead to better decisions than the theoretically optimal procedure.

From a computational point of view, decision procedures can be encoded in algorithms and heuristics. Edward Tsang argues that the effective rationality of an agent is determined by its computational intelligence. Everything else being equal, an agent that has better algorithms and heuristics could make "more rational" (more optimal) decisions than one that has poorer heuristics and algorithms.

A school of economic thought that traditionally assumes that economic agents have bounded rationality is the Austrian school.

7.0. Evolutionary economics: Evolutionary economics is a relatively new economic and diverse school of thought that is inspired by evolutionary biology. Much like mainstream it stresses

complex interdependencies, competition, growth, structural change, and resource constraints but differs in the approaches which are used to analyze these phenomenon.

Mainstream economic reasoning begins with the definition of scarcity, then assumes the existence of a "rational agent" bent solely on the attainment of one goal — the maximization of her/his welfare as defined by that agent. The scheme of valuation ("preferences" or "tastes") used by the decision-maker is also assumed to be constant and native to the agent ("independent preferences"). Given the foregoing stipulations, the determination of the "rational choice" for any agent becomes a straightforward exercise in the differential calculus.

Evolutionary economics does not take the characteristics of either the objects of choice or of the decision-maker as fixed. It purports to challenge the mainstream of the economic discipline in a similar manner to how Charles Darwin challenged previous views of human genealogy with evolutionary theory.

7.1. Predecessors of evolutionary economics: Karl Marx began in the mid-19th century with his schema of stages of historical development, by introducing the notion that "human nature" was not constant and was not determinative of the nature of the social system; on the contrary, he made it a principle that human behavior was a function of the social and economic system in which it occurred.

At approximately the same time, Charles Darwin developed a general framework for comprehending any process whereby small, random variations could be accumulated and selected over time into large-scale changes that resulted in the emergence of wholly novel forms or "speciation".

This was followed shortly after by the work of the American pragmatic philosophers (James, Peirce, Dewey) and the founding of two new disciplines, psychology and anthropology, both of which were oriented toward cataloging and developing explanatory frameworks for the variety of behavior patterns (both individual and collective) that were becoming increasingly obvious to all systematic observers. The state of the world converged with the state of the evidence to make almost inevitable the development of a more modern framework for the analysis of substantive economic issues.

Thorstein Veblen began his career in the midst of this period of intellectual ferment, and as a young scholar came into direct contact with some of the leading figures of the various movements that were to shape the style and substance of the newly-minted social sciences into the next century and beyond. Veblen saw the need for taking account of cultural variation in his approach; no universal "human nature" could possibly be invoked to explain the variety of norms and behaviors that the new science of anthropology showed to be the rule, rather than the exception. His singular analytical contribution was what came to be known as the "ceremonial / instrumental dichotomy"; Veblen saw that every culture is materially-based and dependent on tools and skills to support the "life process", while at the same time, every culture appeared to have a stratified structure of status ("invidious distinctions") that ran entirely contrary to the imperatives of the "instrumental" (read: "technological") aspects of group life. The "ceremonial" was related to the past, and conformed to and supported the tribal legends; "instrumental" was oriented toward the technological imperative to judge value by the ability to

control future consequences. The "Veblenian dichotomy" was a specialized variant of the "instrumental theory of value" due to John Dewey, with whom Veblen was to make contact briefly at the University of Chicago.

The most important works by Veblen include, but are not restricted to, his most famous works (Theory of the Leisure Class (TOLC); Theory of Business Enterprise (TOBE)), but his monograph Imperial Germany and the Industrial Revolution and the essay entitled Why is Economics not an Evolutionary Science have both been influential in shaping the research agenda for following generations of social scientists. TOLC and TOBE together constitute an alternative construction on the neoclassical marginalist theories of consumption and production, respectively. Both are clearly founded on the application of the "Veblenian dichotomy" to cultural patterns of behavior, and are therefore implicitly but unavoidably bound to a critical stance; Veblen's theories cannot be well understood unless one grasps that the dichotomy is at its core a valuational principle. The ceremonial patterns of activity are not bound to just any past, but rather to the one that generated a specific set of advantages and prejudices that underlie the current structure of rewards and power. Instrumental judgments create benefits according to an entirely separate criterion, and therefore are inherently subversive. This line of analysis was more fully and explicitly developed by Clarence E. Ayres of the University of Texas at Austin from the 1920s.

Kenneth Boulding was one of the advocates of the evolutionary methods in social science, as is evident from Kenneth Boulding's Evolutionary Perspective. Kenneth Arrow, Ronald Coase and Douglass North are some of the ‘Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel’ winners who are known by their sympathy to the field. More narrowly the works Jack Downie and Edith Penrose are the sources of many insights for those thinking about evolution at the level of the firm in an industry.

7.2. Schumpeter's "Entwicklung": The evolutionary economics cannot be understood without the contribution of Joseph Schumpeter, who lived in the first half of 20th century. He was the author of the book The Theory of Economic Development. It is important to note that for the word development he used in his native language, the German word "Entwicklung", which can be translated as development or evolution. The translators of the day used the word "development" from the French "développement", as opposed to "evolution" as this was used by Darwin. However it makes more sense to look at the economy as "evolution" (or Entwicklung) than "development", which refers more to bring something to a fixed state, instead of a process that can go anywhere. Schumpeter, in his later writings in English as a professor at Harvard, used the word "evolution", but the damage by the first translators was done. People kept referring to economic development.

In Schumpeter's book he proposed an idea radical for its time: The evolutionary perspective. He based his theory on the assumption of usual macroeconomic equilibrium, which is something like "the normal mode of economic affairs". This equilibrium is being perpetually destroyed by entrepreneurs who try to introduce innovations. A successful introduction of an innovation disturbs the normal flow of economic life, because it forces some of the already existing technologies and means of production to lose their positions within the economy.

7.3. Present state of discussion: One of the major contributions to the emerging field of evolutionary economics has been the publication of 'An Evolutionary Theory of Economic Change' by Richard Nelson and Sidney Winter. These authors have focused mostly on the issue of changes in technology and routines, suggesting a framework for their analysis. If the change occurs constantly in the economy, then some kind of evolutionary process must be in act, and there has been a proposal that this process is Darwinian in nature. Then, mechanisms that provide selection, generate variation and establish self-replication, must be identified.

It has been proposed that markets act as the major selection vehicles. As firms compete, unsuccessful rivals fail to capture an appropriate market share, go bankrupt and have to exit. The variety of competing firms is both in their products and practices, that are matched against markets. Both products and practices are determined by routines that firms use: standardized patterns of actions implemented constantly. By imitating these routines, firms propagate them and thus establish inheritance of successful practices.

Ulrich Witt has proposed that an appropriate tool set for socio-economic evolution analysis is provided by the range of self-organization and complexity theories, that deal with phenomena of emergence and increasing complexity.

As Philip Mirowski has demonstrated in his book 'More Heat than Light', the first 200 years of economic theory was modeled primarily on physics — economic terminology like "labour force", "equilibrium", "elasticity", and "velocity of money", are no accident.

Howard Aldrich, Geoffrey Hodgson, David Hull, Thorbjoern Knudsen, Joel Mokyr, Viktor Vanberg and others have argued that the general Darwinian principles of variation, inheritance and selection apply to social as well as biological entities, despite important detailed differences in the mechanisms and processes involved.

7.4. Axiomatization of evolutionary economics: A number of authors have aimed to outline common features of evolutionary schools in economics. In particular, such attempts were made by Kurt Dopfer, Carsten Herrmann-Pillath and Hardy Hanappi. According to their proposals, empirical axiomatics could be built on three propositions: (1) real phenomena are actualizations of ideas, (2) actualizations are matter-energy manifestations in space and time, (3) real phenomena evolve.

Ideas are articulated in language and thus transported into the social domain. Generic ideas, in particular, can bring about cognitive and behavioral processes, and in this respect they are practical and associated with the notion of ‘productive knowledge’. It is generic ideas that evolve and form causal powers underlying the change. Evolutionary economics is essentially about changes in generic knowledge, and involves transition between actualized generic ideas. Actual phenomena, being manifestations of ideas, are seen as ‘carriers of knowledge’.

Three analytical concepts corresponding to ontological axiomatics are thus:

(1) carriers of knowledge,
(2) generic ideas as components of a process, and
(3) evolutionary-formative causality.

The latter implies that no law that could apply universally in space and time, could be formulated. Instead, a 'variable law' (in terms of Charles Peirce) could be speculated about, that is a generic idea that shapes the social dynamics but changes over time.

The logic of the invariant of evolutionary process in social science is seen as the following sequence, described as an 'evolutionary regime':

In the first phase, generic ideas originate.
In the second phase, macroscopic (population-level) adoptions governed by various mechanisms (selection, path dependence, learning effects etc.) occur.
In the third phase, stabilization based on high-frequency adoption, happens.

Thus, evolutionary process is essentially irreversible, and it is seen as a transition from one state of generic idea dominance to another. Evolution represents a genealogy of regimes, that come into existence through adoption by populations of economic agents. This can be achieved either through Darwinian evolution (as considered by Nelson and Winter), or through emergence of 'critical masses' as suggested by Witt.

Thus, evolutionary economics is concerned with the transformation of generic ideas, or social and technical knowledge, that determine states of socio-economic system, and dominating economic phenomena (products, technologies, institutional arrangements) within these. Every possible state, form and determining idea is a passing one, but its emergence is no occasion, it is guided by the logic of evolutionary laws.

Frank (1998), Foster and Metcalfe (2001) and Dopfer and Potts (2008) aptly outline the characteric features of evolutionary economics. A rich material on evolutionary economics can be obtained at http://www.webng.com/economics.

8.0. Agent-based computational economics: An agent-based model (ABM) is a computational model for simulating the actions and interactions of autonomous individuals in a network, with a view to assessing their effects on the system as a whole. It combines elements of game theory, complex systems, emergence, computational sociology, multi agent systems, and evolutionary programming. Monte Carlo Methods are used to introduce randomness.

The models simulate the simultaneous operations of multiple agents, in an attempt to re-create and predict the actions of complex phenomena. The process is one of emergence from the lower (micro) level of systems to a higher (macro) level. The individual agents are presumed to be acting in what they perceive as their own interests, such as reproduction, economic benefit, or social status, and their knowledge is limited. ABM agents may experience "learning", adaptation, and reproduction.

8.1. History of agent-based computational economics: The idea of agent-based modeling was developed as a relatively simple concept in the late 1940s. Since it requires computation-intensive procedures, it did not become widespread until the 1990s.

The history of the agent-based model can be traced back to the Von Neumann machine, a theoretical machine capable of reproduction. The device von Neumann proposed would follow precisely detailed instructions to fashion a copy of itself. The concept was then improved by von Neumann's friend Stanisław Ulam, also a mathematician; Ulam suggested that the machine be built on paper, as a collection of cells on a grid. The idea intrigued von Neumann, who drew it up—creating the first of the devices later termed cellular automata.

Another improvement was introduced by the mathematician John Conway. He constructed the well-known Game of Life. Unlike von Neumann's machine, Conway's Game of Life operated by tremendously simple rules in a virtual world in the form of a 2-dimensional checkerboard.

The creation of agent-based models of social systems is often credited to the computer scientist Craig Reynolds. He tried to model the reality of lively biological agents, known as artificial life, a term coined by Christopher Langton.

At the same time, during the 1980s, social scientists, mathematicians, operations researchers, and a scattering of people from other disciplines developed Computational and Mathematical Organization Theory (CMOT). This field grew as a special interest group of The Institute of Management Sciences (TIMS) and its sister society, the Operations Research Society of America (ORSA). Through the mid-1990s, the field focused on such issues as designing effective teams, understanding the communication required for organizational effectiveness, and the behavior of social networks. With the appearance of SWARM in the mid-1990s and RePast in 2000, as well as some custom-designed code, CMOT -- later renamed Computational Analysis of Social and Organizational Systems (CASOS) -- incorporated more and more agent-based modeling.

8.2. Theory of agent-based modeling: Most computational modeling research describes systems in equilibrium or as moving between equilibria. Agent-based modeling, however, using simple rules, can result in far more complex and interesting behavior. The three ideas central to agent-based models are ***social agents as objects***, **emergence**, and **complexity**. Agent-based models consist of dynamically interacting rule based agents. The systems within which they interact can create real world-like complexity. These agents are: (i) Intelligent and purposeful, but not so intelligent as to reach the cognitive closure implied by game theory, (ii) Situated in space and time - they reside in networks and in lattice-like neighborhoods. The location of the agents and their responsive and purposeful behavior are encoded in algorithmic form in computer programs. The modeling process is best described as inductive. The modeler makes those assumptions thought most relevant to the situation at hand and then watches phenomena emerge from the agents' interactions. Sometimes that result is an equilibrium. Sometimes it is an emergent pattern. Sometimes, however, it is an unintelligible mangle.

In some ways, agent-based models complement traditional analytic methods. Where analytic methods enable humans to characterize the equilibria of a system, agent-based models allow the possibility of generating those equilibria. This generative contribution may be the most mainstream of the potential benefits of agent-based modeling. Agent-based models can explain the emergence of higher order patterns -- network structures of terrorist organizations and the Internet, power law distributions in the sizes of traffic jams, wars, and stock market crashes, and social segregation that persists despite populations of tolerant people. Agent-based models also

can be used to identify lever points, defined as moments in time in which interventions have extreme consequences, and to distinguish among types of path dependency.

Rather than focusing on stable states, the models consider a system's robustness -- the ways that complex systems adapt to internal and external pressures so as to maintain their functionalities. The task of harnessing that complexity requires consideration of the agents themselves -- their diversity, connectedness, and level of interactions.

8.3. Applications of agent-based models: Agent-based models have been used since the mid-1990s to solve a variety of business and technology problems. Examples of applications include supply chain optimization and logistics, modeling of consumer behavior, including word of mouth, social network effects, distributed computing, workforce management, and portfolio management. They have also been used to analyze traffic congestion In these and other applications, the system of interest is simulated by capturing the behavior of individual agents and their interconnections. Agent-based modeling tools can be used to test how changes in individual behaviors will affect the system's emerging overall behavior.

Other models have analyzed the spread of epidemics, the threat of biowarfare, the growth and decline of ancient civilizations, and the human immune system.

9.0. New institutional economics: New institutional economics (NIE) is an economic perspective that attempts to extend economics by focusing on the social and legal norms and rules that underlie economic activity.

9.1. Overview of new institutional economics: Although NIE has its roots in Ronald Coase's fundamental insights about the critical role of institutional frameworks and transaction costs for economic performance, at present NIE analyses are built on a more complex set of methodological principles and criteria. They now depart from both mainstream Neoclassical economics and "old" institutional economics, though authors often care about both efficiency and distribution issues. The term 'New Institutional Economics' was coined by Oliver Williamson in 1975.

Among the many concepts/aspects that are often taken into account in current NIE analyses these can be mentioned: organizational arrangements, transaction costs, credible commitments, modes of governance, persuasive abilities, social norms, ideological values, decisive perceptions, gained control, enforcement mechanism, asset specificity, human assets, social capital, asymmetric information, strategic behavior, bounded rationality, opportunism, adverse selection, moral hazard, contractual safeguards, surrounding uncertainty, monitoring costs, incentives to collude, hierarchical structures, bargaining strength, etc.

9.2. Institutional levels: Although no single, universally accepted set of definitions has been developed, most scholars doing research under the NIE methodological principles and criteria follow Douglass North's demarcation between institutions and organizations. Institutions are the "rules of the game", consisting of both the formal legal rules and the informal social norms that govern individual behavior and structure social interactions (institutional frameworks).

Organizations, by contrast, are those groups of people and the governance arrangements they create to coordinate their team action against other teams performing also as organizations. Firms, Universities, clubs, medical associations, unions etc are some examples.

Because some institutional frameworks are realities always "nested" inside other broader institutional frameworks, this clear demarcation is always blurred in actual situations. A case in point is a University. When the average quality of its teaching services must be evaluated, for example, a University may be approached as an organization with its people, physical capital, the general governing rules common to all that were passed by the University governing bodies etc. However, if the task consists of evaluating people's performance in a specific teaching department, for example, along with their own internal formal and informal rules, then the University as a whole enters the picture as an institution. General University rules, then, form part of the broader institutional framework influencing people's performance at the said teaching department.

10.0. Post-autistic economics: The movement for Post-Autistic Economics (PAE) was born through the work of Sorbonne economist Bernard Guerrien. Started in Spring 2000 by group of disaffected French economics students, Post-Autistic Economics first reached a wider audience in June 2000 after an interview in Le Monde.

It was supported by the Cambridge Ph.D. students in 2001 with the publication of "Opening Up Economics: A Proposal By Cambridge Students", later signed by 797 economists.

The term autistic is used in an informal way, synonymous to "closed-minded" or "self-absorbed". It has been criticized for using the medical diagnosis, autism, as a derogatory expression. The movement is best seen as a forum of different groups critical of the current mainstream: from behavioral and heterodox to feminist, green economics and econo-physics.

10.1. Concept underlying the PAE: PAE has challenged standard neoclassical assumptions and incorporated ideas from sociology and psychology into economic analysis. Specifically, the notions of utility theory, rational choice, production and efficiency theory (Pareto optimality), and game theory have been criticised: one much-discussed article is *Is There Anything Worth Keeping in Standard Microeconomics?*. Other topics include "Gross National Happiness", realism vs. mathematical consistency, "Thermodynamics and Economics", or "Irrelevance and Ideology". Contributors include Bruce Caldwell, James K. Galbraith, Robert L. Heilbroner, Bernard Guerrien, Emmanuelle Benicourt, Ha-Joon Chang, Herman Daly and Richard Wolff.

11.0. Ecological economics: Ecological economics is a transdisciplinary field of academic research within economics that aims to address the interdependence between human economies and natural ecosystems. It is distinguished from environmental economics by its connection to outside disciplines within the natural sciences, social sciences, and humanities and its focus on the "scale" conundrum, or how to operate an economy within the ecological constraints of earth's natural resources. According to ecological economist Malte Faber, ecological economics is defined by its focus on nature, justice, and time. Issues of intergenerational equity, irreversibility of environmental change, uncertainty of long-term outcomes, and sustainable development guide ecological economic analysis and valuation.

The identity of ecological economics as a field has been described as fragile, with no generally accepted theoretical framework and a knowledge structure which is not clearly defined. Ecological economists have questioned fundamental mainstream economic approaches such as cost-benefit analysis, and the separability of economic values from scientific research, contending that economics is unavoidably normative rather than positive (empirical). Positional analysis, which attempts to incorporate time and justice issues, is proposed as an alternative.

The related field of biophysical economics, sometimes referred to also as bio-economics, is based on a conceptual model of the economy connected to, and sustained by, a flow of energy, materials, and ecosystem services. Analysts from a variety of disciplines have conducted research on the economy-environment relationship, with concern for energy and material flows and sustainability, environmental quality, and economic development.

In ecological economics, a complex circular flow diagram reflects the input of solar energy, which sustains natural inputs and environmental services, which are then used as factors of production. After these natural inputs are consumed, they are outputted as pollution and waste. The potential of an environment to make services and materials is called an environment's source function, and this function is depleted as resources are consumed or pollution contaminates the resources. The sink function describes an environment's ability to absorb and render harmless waste and pollution; when waste output exceeds the limit of the sink function, long-term damage occurs.

The economic value of natural capital is accepted by mainstream environmental economics, but is emphasized as especially important in ecological economics. Ecological economists may begin by estimating how to maintain a stable environment before assessing the cost in monetary terms. Ecological economist Robert Costanza led an attempted valuation of the global ecosystem in 1997. Initially published in Nature, the article concluded on $33 trillion with a range from $16 trillion to $54 trillion (in 1997, total global GDP was $27 trillion. Half of the value went to nutrient cycling. The open oceans, continental shelves, and estuaries had the highest total value, and the highest per-hectare values went to estuaries, swamps/floodplains, and seagrass/algae beds. The work was criticized by articles in Ecological Economics Volume 25, Issue 1, but the critics acknowledged the positive potential for economic valuation of the global ecosystem.

An important motivation for the emergence of ecological economics has been criticism of the assumptions and approaches of traditional environmental and resource economics, and further a need to distinguish from the social goals of green politics.

By contrast, ecological economics presents a scientific but still more pluralistic approach to study of environmental problems and policy solutions, characterized by systems perspectives and a focus on physical and biological contexts and long-term environmental sustainability. Ecological economics might be regarded as a version of environmental science or human geography with much emphasis on social, political, economic, behavioral and ethical issues. However, it seeks to state its assumptions in a framework similar to that of classical economics with expanded definitions of infrastructure, defense, currency and justice that match the constraints of a society in which carrying capacity is now scarcer.

Various competing schools of thought exist in the field. Some are close to resource and environmental economics while others are far more heterodox in outlook. An example of the latter is the European Society for Ecological Economics. An example of the former is the Swedish Beijer International Institute of Ecological Economics.

11.1. Distinctive features: What differentiates ecological economics schools from classical thought is that capital asset analysis (land, labour, financial capital) has been expanded to make land more active and include the operations of other ecosystems such as rivers, oceans and the atmosphere. In other words, land has been broadened into the concept of natural capital. Furthermore, the analysis of labour is often much more fine-grained and includes examination of the unique ways in which labour adapts to its surroundings. Indigenous languages, for instance, tend to acquire distinctions that match the ecosystems and lifeways in which they operate to enable awareness that colonialism and globalization generally override and ignore. The social capital and possibly unique talents or instructions of a culture will be more closely identified with the location and surrounding ecosystems than in the classical.

Ecological economics inherits some mathematical assumptions from neoclassical economics in that it will employ aggregate measures for genuinely aggregated resources such as the CO2 absorption capacity of the atmosphere (the amount it can absorb before global warming begins to occur). It however generally rejects the neoclassical assumption that local differences in the means of production or extraction method are just another externality, since living ecosystems are impossible to repay or reproduce and often extraordinarily expensive to replace or augment. Unlike the neoclassical assumption of a high-liquidity world in which there are a near infinite number of technology and supply substitutes, ecological economics tends instead to assume that only a narrow range of such substitutes, similar to those used in nature, will prove feasible as a long-term economic proposition for those living within the biosphere. The major and most obvious difference is that neoclassical economics is wholly unconcerned with the proportion of the supply chain absorbed by transport costs and also unconcerned with the issues in alienation of property rights when consuming goods from far away.

The most cogent example of how the different theories treat similar assets is tropical rainforest ecosystems, most obviously the Yasuni region of Ecuador. While this area has substantial deposits of bitumen it is also one of the most diverse ecosystems on Earth and some estimates establish it has over 200 undiscovered medical substances in its genomes - most of which would be destroyed by logging the forest or mining the bitumen. Effectively, the instructional capital of the genomes is undervalued by both classical and neoclassical means which would view the rainforest primarily as a source of wood, oil/tar and perhaps food. Increasingly the carbon credit for leaving the extremely carbon-intensive ("dirty") bitumen in the ground is also valued - the government of Ecuador set a price of US$350M for an oil lease with the intent of selling it to someone committed to never exercising it at all and instead preserving the rainforest. Bill Clinton, Paul Martin and other former world leaders have become closely involved in this project which includes lobbying for the issue of International Monetary Fund Special Drawing Rights to recognize the rainforest's value directly within the framework of the Bretton Woods institutions. If successful this would be a major victory for advocates of ecological economics as the new mainstream form of economics.

11.2. History and development of ecological economics: The first book with the title Ecological Economics was published in Europe by Juan Martinez-Alier tracing the history of ecological critiques of economics since the 1880s to the 1950s. European conceptual founders include Nicholas Georgescu-Roegen, William Kapp and Karl Polanyi. Furthermore, some key concepts of what is now ecological economics are evident in the writings of E.F. Schumacher, whose book Small Is Beautiful – A Study of Economics as if People Mattered was published just a few years before the first edition of Herman Daly's comprehensive and persuasive Steady-State Economics.

The antecedents can be traced back to the Romantics of the 1800s as well as some Enlightenment political economists of that era. Concerns over population were expressed by Thomas Malthus, while John Stuart Mill hypothesized that the "stationary state" of an economy might be something that could be considered desirable, anticipating later insights of modern ecological economists, without having had their experience of the social and ecological costs of the dramatic post-World War II industrial expansion. As Martinez-Alier explores in his book the debate on energy in economic systems can also be traced into the 1800s e.g. Nobel prize-winning chemist, Frederick Soddy.

In North America, conceptual founders include economists Kenneth Boulding and Herman Daly, ecologists C.S. Holling, H.T. Odum and Robert Costanza, biologist Gretchen Daily and physicist Robert Ayres. Daly and Costanza were part of the institutional founding of the field - resulting in the establishment of the academic journal Ecological Economics and the International Society for Ecological Economics (ISEE). Some attribute origination of ecological economics as a specific field per se to professor Herman Daly, University of Maryland, a former economist at the World Bank. Ecological economics has been popularized by ecologist and University of Vermont Professor Robert Costanza. CUNY geography professor David Harvey explicitly added ecological concerns to political economic literature. This parallel development in political economy has been continued by analysts such as sociologist John Bellamy Foster.

The Romanian economist Nicholas Georgescu-Roegen, who was among Daly's teachers at Vanderbilt University, provided ecological economics with a modern conceptual framework based on the material and energy flows of economic production and consumption. His magnum opus, The Entropy Law and the Economic Process, has been highly influential.

11.3. Green economics: Green Economics is a more recent development that goes beyond the traditional scope of Ecological Economics but shares some of its basic principles. Green Economics comprises all aspects and sub-disciplines of economics, not only ecology related, and analyses economic issues with a *pluralistic, holistic and long term view*. The aim of this emerging discipline is the reform of mainstream economics towards an unbiased understanding of economic facts and the political choices available to enhance the economic freedom available to all stakeholders. Comprehensive academic work in this field is organised and co-ordinated by the Green Economics Institute, an academic think tank founded in 2004 in the UK, which edits the *International Journal of Green Economics*. (The term Green Economics is in addition employed by UK based individuals acting as a political lobby and activist forum rather than taking the purely academic approach dominant amongst other ecological economists).

Articles by Inge Ropke and Clive Spash cover the development and modern history of ecological economics and explain its differentiation from resource and environmental economics, as well as some of the controversy between American and European schools of thought.

11.4. Objectives of ecological economics: The primary objective of ecological economics is to ground economic thinking and practice in physical reality, especially in the laws of physics (particularly the laws of thermodynamics) and in knowledge of biological systems. It accepts as a goal the improvement of human well-being through development, and seeks to ensure achievement of this through planning for the sustainable development of ecosystems and societies. Of course the terms development and sustainable development are far from lacking controversy. Richard Norgaard argues traditional economics has hi-jacked the development terminology in his book Development Betrayed. Well-being in ecological economics is also differentiated from welfare as found in mainstream economics and the 'new welfare economics' from the 1930s which informs resource and environmental economics, both of which are anthropocentric. This entails a limited preference utilitarian conception of value i.e., Nature is valuable to our economies, that is because people will pay for its services such as clean air, clean water, encounters with wilderness, etc.

Ecological economics distinguishes itself from neoclassical economics primarily by its assertion that the economy is an embedded within an environmental system. Ecology deals with the energy and matter transactions of life and the Earth, and the human economy is by definition contained within this system. Ecological economists feel neoclassical economics has ignored the environment, at best relegating it to be a subset of the human economy. Economic theory, as encapsulated in general equilibrium models, then assume both an infinite resource base and also infinite waste sinks with no feedbacks; in simpler terms, resources never run out and pollution never occurs. This allows neoclassical economics to claim theoretically that infinite economic growth is both possible and desirable.

However, this belief disagrees with much of what the natural sciences have learned about the world, and, according to Ecological Economics, completely ignores the contributions of Nature to the creation of wealth e.g., the planetary endowment of scarce matter and energy, along with the complex and biologically diverse ecosystems that provide goods and ecosystem services directly to human communities: micro- and macro-climate regulation, water recycling, water purification, storm water regulation, waste absorption, food and medicine production, pollination, protection from solar and cosmic radiation, the view of a starry night sky, etc.

There has then been a move to regard such things as natural capital and ecosystems functions as goods and services. However, this is far from uncontroversial within ecology or ecological economics due to the potential for narrowing down values to those found in mainstream economics and the danger of merely regarding Nature as a commodity. This has been referred to as ecologists 'selling out on Nature'. There is then a concern that ecological economics has failed to learn from the extensive literature in environmental ethics about how to structure a plural value system.

11.5. Ecological economics and allocation of resources: Resource and neoclassical economics focus primarily on the efficient allocation of resources, and less on two other fundamental economic problems which are central to ecological economics: distribution (equity) and the

scale of the economy relative to the ecosystems upon which it is reliant. Ecological Economics also makes a clear distinction between growth (quantitative) and development (qualitative improvement of the quality of life) while arguing that neoclassical economics confuses the two. Ecological economics challenges the common normative approach taken towards natural resources, claiming that it misvalues nature by displaying it as interchangeable with human capital-labor and technology. Ecological Economics counters this convention by asserting that human capital is instead complementary to and dependent upon natural systems, as human capital inevitably derives from natural systems. From these premises, it follows that economic policy has a fiduciary responsibility to the greater ecological world, and that, by misvaluing the importance of nature, sustainable progress (as opposed to economic growth) - which is the only solution to elevating the standard of living for citizens worldwide - will not result. Furthermore, ecological economists point out that, beyond modest levels, increased per-capita consumption (the typical economic measure of "standard of living") does not necessarily lead to improvements in human well-being, while this same consumption can have harmful effects on the environment and broader societal well-being.

11.6. Energy considerations in ecological economics: Ecological Economics rejects the view of energy economics that growth in the energy supply is related directly to well being, focusing instead on biodiversity and creativity - or natural capital and individual capital, in the terminology sometimes adopted to describe these economically. In practice, ecological economics focuses primarily on the key issues of uneconomic growth and quality of life. Ecological economists are inclined to acknowledge that much of what is important in human well-being is not analyzable from a strictly economic standpoint and suggests an interdisciplinary approach combining social and natural sciences as a means to address this.

Thermo-economics (the main basis of energy economics) is based on the proposition that the role of energy in biological evolution should be defined and understood through the second law of thermodynamics but in terms of such economic criteria as productivity, efficiency, and especially the costs and benefits (or profitability) of the various mechanisms for capturing and utilizing available energy to build biomass and do work. As a result, thermo-economics are often discussed in the field of ecological economics, which itself is related to the fields of sustainability and sustainable development.

An energy balance can be used to track energy through a system, and is a very useful tool for determining resource use and environmental impacts, using the First and the Second laws of thermodynamics, to determine how much energy is needed at each point in a system, and in what form that energy is a cost in various environmental issues. The energy accounting system keeps track of energy in, energy out, and non-useful energy versus work done, and transformations within the system.

Energy Accounting is the hypothetical system of distribution, proposed by Technocracy Incorporated in the Technocracy Study Course, which would record the energy used to produce and distribute goods and services consumed by citizens in a Technate.

Scientists have written and speculated on different aspects of energy accounting.] Many variations of energy accounting are in use now, as this issue relates to current (price system) economics directly, as well as projected models in possible Non-market economics systems.

In Wealth, Virtual Wealth and Debt, Frederick Soddy turned his attention to the role of energy in economic systems. He criticized the focus on monetary flows in economics, arguing that “real” wealth was derived from the use of energy to transform materials into physical goods and services. Soddy’s economic writings were largely ignored in his time, but would later be applied to the development of bio-economics and ecological economics in the late 20th century.

11.7. Environmental services: A study was carried out by Costanza and colleagues to determine the 'price' of the services provided by the environment. This was determined by averaging values obtained from a range of studies conducted in very specific context and then transferring these without regard to that context. Dollar figures were averaged to a per hectare number for different types of ecosystem e.g. wetlands, oceans. A total was then produced which came out at 33 trillion US dollars (1997 values), more than twice the total GDP of the world at the time of the study. This study was criticized by pre-ecological and even some environmental economists - for being inconsistent with assumptions of financial capital valuation - and ecological economists - for being inconsistent with an ecological economics focus on biological and physical indicators.

The whole idea of treating ecosystems as goods and services to be valued in monetary terms remains controversial to some. A common objection is that life is precious or priceless, but this demonstrably degrades to it being worthless under the assumptions of any branch of economics. Reducing human bodies to financial values is a necessary part of every branch of economics and not always in the direct terms of insurance or wages. Economics, in principle, assumes that conflict is reduced by agreeing on voluntary contractual relations and prices instead of simply fighting or coercing or tricking others into providing goods or services. In doing so, a provider agrees to surrender time and take bodily risks and other (reputation, financial) risks. Ecosystems are no different than other bodies economically except insofar as they are far less replaceable than typical labour or commodities.

Despite these issues, many ecologists and conservation biologists are pursuing ecosystem valuation. Biodiversity measures in particular appear to be the most promising way to reconcile financial and ecological values, and there are many active efforts in this regard. The growing field of biodiversity finance began to emerge in 2008 in response to many specific proposals such as the Ecuadoran Yasuni proposal or similar ones in the Congo. US news outlets treated the stories as a "threat" to "drill a park" reflecting a previously dominant view that NGOs and governments had the primary responsibility to protect ecosystems. However Peter Barnes and other commentators have recently argued that a guardianship/trustee/commons model is far more effective and takes the decisions out of the political realm.

Commodification of other ecological relations as in carbon credit and direct payments to farmers to preserve ecosystem services are likewise examples that permit private parties to play more direct roles protecting biodiversity. The United Nations Food and Agriculture Organization achieved near-universal agreement in 2008 that such payments directly valuing ecosystem preservation and encouraging permaculture were the only practical way out of a food crisis.

11.8. Reconsideration of externalities: Ecological economics is founded upon the view that the assumption that environmental and community costs and benefits are mutually canceling "externalities" is not warranted. Juan Martinez Alier, for instance, shows that the bulk of

consumers are automatically excluded from having an impact upon the prices of commodities, as these consumers are future generations who have not been born yet. The assumptions behind future discounting, which assume that future goods will be cheaper than present goods, has been criticised by Fred Pearce and by the recent Stern Report. Although the Stern report itself does employ discounting and has been criticised by ecological economists. Concerning these externalities, Paul Hawken argues that the only reason why goods produced unsustainably are usually cheaper than goods produced sustainably is due to a hidden subsidy, paid by the non monetarised human environment, community or future generations. These arguments are developed further by Hawken, Amory and Hunter Lovins in "Natural Capitalism: Creating the Next Industrial Revolution".

12.0. Concluding remarks: As it may be observed from the description given above, the different currents in modern economics are not yet synthesized, although each one revolts against the neoclassical orthodoxy. We may expect a synthesis in the near future that will replace neoclassical economics from the citadel of mainstream. Teaching of these strands of new economics has already begun in many universities, although in an un-integrated manner. However, until the neoclassical microeconomics and macroeconomics are replaced by their alternatives and necessary tools of economic analysis are developed, neoclassicism would not give a way to modern economics.

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