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Abstract

The scientific methodology of classical physics has been a constant influence in the development of orthodox economics. Clear signs of this can be found in the works of many classical economists such as Smith, Say, Cairnes and Mill. The physics influence became more apparent with the emergence of marginalism. The economic thought of F. Y. Edgeworth, however, is the peak of the influence of classical physics to economics. In Edgeworth's *Mathematical Psychics*, the identification of maximum energy in physics with that of the maximum pleasure in economic calculus, is central in his thought. In the same manner, I. Fisher, the founder of marginalism in the US, promoted a classical physics based economic methodology. The close analogy of physics and economics concepts and the application of tools from hydrodynamics to economic theory, are basic characteristics of his work. These views eventually dominated orthodox economic methodology. The paper argues that, apart from establishing the physics scientific ideal in economics, both of these authors provided the methodological justification for its adoption in economics. It also examines their subsequent influence on the formation of the current methodological approach in orthodox economics. In particular, it discusses their influence on key components of current mainstream economics such as: extensive use of mathematics, aversion to methodological discourse and anti-psychologism.

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I. Introduction

The desire to elevate the scientific status of economics to that of the physical sciences has a long presence in the history of economic analysis (e.g. Mirowski, 1984). A number of key figures in the classical school such as A. Smith, J. B. Say and J. S. Mill viewed physical sciences as the ideal scientific model for economics. Thus, examples of the analogy between economics and physical sciences can be found in Smith (astronomy), Cairnes (chemistry), Say (chemistry and physics) and Mill, 1874 (geometry) (Smith, 1980ed, Cairnes, 1875; Say, 1803; Mill, 1874). The strive to imitate the methods of physics became much more apparent with the emergence of the marginalist school. Jevons' assertion that the theory of economy presents a close analogy to the science of statical mechanics (Jevons, 1871, p.viii), and Walras' prediction that mathematical economics will rank with the mathematical sciences of astronomy and mechanics (Walras, 1965, p.47, 48), are indicative examples in this respect. However, the work of second generation marginalist F. Y. Edgeworth, represents the highest point of physics and in particular, of classical physics methodological influence. In his main work *Mathematical Psychics* (1881), Edgeworth not only carried the analogy to its extreme, but also provided a thorough methodological justification. Similarly, the work of I. Fisher, the popularizer of marginalism and neoclassical economics in the US, also exhibits the same tendency. Fisher took terms and concepts from classical physics (especially hydraulics) and transferred them directly to economics, also providing the appropriate methodological basis for their use. Thus, the writings of those two influential economists were paramount for the general acceptance of "economics being parallel to physics" methodological paradigm.

The physical science ideal has played, and still plays a key role in the formation of orthodox economic methodology (see also Debreu, 1991; Drakopoulos, 1994). The paper discusses the development of this ideal in the works of Edgeworth and Fisher, also demonstrating that these authors provided the methodological justification for its adoption in economics. It also examines the most important consequences of this methodological stance for contemporary mainstream economics. In particular, the paper argues that the high degree of formalism of current mainstream economic theory, the established tradition of anti-psychologism, and the relegation of methodological critique, are the most important consequences of the physics methodological ideal. The paper starts with a discussion of the methodological approach of Edgeworth. The following section concentrates on Fisher's methodological ideas. Section four examines the most important repercussions of their influence for contemporary mainstream economics, and the final section concludes.

II. Edgeworth: Physics and Psychics

For most historians of economic thought, Edgeworth is considered to be one of the most influential figures of marginalism and of the early neoclassical economics. Edgeworth made extremely significant contributions to numerous subfields of economics including contract and exchange theory, the theory of monopoly and duopoly and taxation theory. However, the impact of his methodological approach for the subsequent development of mainstream economic methodology has not been adequately appreciated by most economic methodologists. More specifically, Edgeworth's most important work *"Mathematical Psychics: An Essay of the Application of Mathematics to Moral Sciences*" (1881) sets the basis for the methodological justification of formalism in social sciences and particularly in economics. Methodological arguments supporting the use of mathematics in economics can be found in the works of previous theorists such as Cournot, Jevons, and Walras (Turk, 2012). However, Edgeworth provides a very systematic methodological grounding for the use of mathematics in the study of social phenomena and more importantly, of the methodological ideal of physics. In this sense, Edgeworth's work represents the height of the physics emulation in the history of economic discourse. The opening page of his main work is indicative:

> An Analogy is suggested between the Principles of Greatest Happiness, Utilitarian or Egoistic, which constitute the first Principles of Ethics and Economics, and those Principles of Maximum Energy which are among the highest generalizations of Physics and in virtue of which mathematical reasoning is applicable to physical phenomena quite as complex as human life (Edgeworth,1881, p.v)

His next step is to provide a detailed methodological justification for the close analogy between physics and social sciences and particularly, economics. The first argument supporting the employment of the methods of mathematical physics to social science, is based on the assumption that every social phenomenon is the concomitant of a physical phenomenon . As he states:

> The application of mathematics to the world of soul is countenanced by the hypothesis (agreeable to the general hypothesis that every psychical phenomenon is the concomitant, and in some sense the other side of a physical phenomenon), the particular hypothesis adopted in these pages, that Pleasure is the concomitant of Energy. *Energy* may be regarded as the central idea of Mathematical Physics; *maximum energy* the object of principal investigations in that science. By aid of this conception we reduce into scientific order physical phenomena, the complexity of which may be compared with the complexity

> which appears so formidable in Social Science. (Edgeworth,1881, p.9, italics in original).

Given the close connection of Energy and Pleasure, the maximization principle in the social sciences mentioned in the opening quotation, is easier to be accepted as a fundamental concept in economics.

The second important reason for the application of mathematics to economics is the quantitative nature of the discipline. In Edgeworth's words:

> Quantity of labour, quantity of pleasure, quantity of sacrifice and enjoyment, greatest average happiness, these are no dreams of German metaphysics, but the leading thought of leading Englishmen and corner-stone conceptions, upon which rest the whole systems of Adam Smith, of Jeremy Bentham, of John Mill, and of Henrey Sidgwick. (Edgeworth,1881, pp.97,98)

In order to respond to the plausible point that data in physics is much more sophisticated than data in economics, Edgeworth argues that the lack of precise numerical data and exact functional relations in economics, is not an obstacle to the application of mathematical methods. He even cites the example of hydrodynamics where the available data is similar to economic data and where relations among variables are central (Edgeworth,1881, pp.4,5).

The application of mathematics and tools from physics is greatly facilitated by the combination of Utilitarianism with economics under the methodology of "mathematical psychics" (see also Creedy 1986, Mirowski, 1984; 1994). Therefore, the central idea of the 'Hedonic Calculus' is the maximization of utility which naturally facilitates the application of optimization methods from physics to economics. The following passage is representative of his views on this matter:

> Now, it is remarkable that the principal inquires in Social Science may be viewed as *maximum-problems*. For Economics investigates the arrangements

> between agents each tending to his own *maximum* utility; and Politics and (Utilitarian) Ethics investigate the arrangements which conclude to the *maximum* sum total of utility. Since, then, Social Science, as compared with the Calculus of Variations, starts from similar data -*loose quantitative relations*-and travels to a similar conclusion –determination of *maximum*- why should it not pursue the same method, Mathematics? (Edgeworth,1881, pp.6,7 italics in original).

Following the above arguments, Edgeworth provides many specific examples demonstrating specific applications of mathematical reasoning appropriate to economics. The case of the calculus of variations is central:

> [i]t is the first principle of the calculus of variations that a varying quantity attains a maximum when the first term of variation vanishes, while the second term is negative (mutatis mutandis, for a minimum)… In the simple cases which in the infancy of Mathematical Psychics are along presented in these pages, we know by observation not what the second term is, but that it is continually negative (Edgeworth,1881, p. 91).

The aim of a unified science of physical and mental phenomena can be found in his notion of 'psychophysics'. Edgeworth often cites contemporary works in psychology and especially the work of psychophysicists such as Weber, Fechner, and Wundt. One can note here the contrast with the subsequent aversion by most orthodox theorists of incorporating research from psychology into economics. In particular, Edgeworth states:

> This 'moral arithmetic' is perhaps to be supplemented by moral differential calculus, the Fechnerian method applied to pleasures in general. For Wundt has shown that sensuous pleasures may thereby be measured, and, as utilitarians hold, all pleasures are commensurable. (Edgeworth,1881, p.60)

Edgeworth was very supportive of employing the findings of psychophysics into the economic and utilitarian calculus. A good example in this respect, is Fechner's Law which relates the quantity of sensation to the quantity of stimulus (intensity of stimulus), and the stimulus threshold. In his previous work (1877), Edgeworth modified this "Law" in view of his subsequent hedonic calculus as follows:

$$\pi = k \left| f(y) - f(\beta) \right|$$

where the symbols π , k , f , y and β respectively denote, 'the pleasure of a sentient element', 'capacity for pleasure', a function which the first differential is positive and the second is negative, the quantity of pleasure for stimulus and 'the "threshold", the lowest value of stimulus for which there is sense of pleasure at all', while β and k are co-efficients' (Edgeworth 1877, p.42). He will employ this relationship in order to set a basis for his utilitarian calculus where he ultimately links it to the Bentham's Greatest Happiness Principle and even to the Malthusian relationship between the quantity of food and the level of population (see also Newman, 1987, pp.90-91). Furthermore, Edgeworth contributed to the spread of statistical methods in economics. His works "Methods of Statistics" (1885) and 'Observation and Statistics' (1887) became extremely influential for the theory and application of statistical techniques to social and economic data (see also Stigler 1986; Baccini, 2007).

Edgeworth's work and especially his *Mathematical Psychics,* represents the peak of the combination of the application of mathematical and physics tools to economics. His identification of maximum energy of physics with that of the maximum pleasure in economic calculus, is Edgeworth's central idea. In addition, his conception of man as a pleasure machine clearly implies the legitimacy of incorporating psychophysics into economic theory. Therefore, Edgeworth's work represents the quintessence of the strive to transform economics into exact science on a par with physical sciences.

III. Fisher: Hydraulics and Economics

Edgeworth's methodological stance gained momentum among subsequent main figures in the history of mainstream economics. Thus, after Edgeworth, there was further incorporation of mathematics and methods from mathematical physics in economic theory. The next figure who contributed to the formation of current ideas about method in economics was Irwin Fisher who is considered to be one of the most important promoters of marginalism in America. According to many specialists, Irving Fisher, accomplished the most thoroughgoing mathematization of marginalist theory (e.g. Breslau, 2003; Zouboulakis, 2003). In line with Edgeworth, his methodological viewpoint is focused on the direct analogy between economics and physics. The approval of Edgeworth to Fishers' approach can be seen by Edgeworth's book review of *Mathematical Investigations* in the *Economic Journal* (1893). Edgeworth speaks highly of this work and especially Fisher's use of analogies from physics. He praises Fisher's analogy of economic and mechanical phenomena and especially the illustration of pure economics with hydrodynamics (Edgeworth, 1893).

One of Fisher's doctoral supervisors was the influential theoretical physicist Willard Gibbs. Fisher was much affected and probably impressed by Gibbs' physics methods. Thus, in order to complement the arguments in his doctoral thesis, he built an elaborate hydraulic machine with pumps and levers, allowing him to demonstrate visually how the equilibrium prices in the market adjusted in response to changes in supply or demand. More specifically, he devised a liquid dynamic model of the behaviour of prices in general equilibrium. In this model, there are tubes connecting the various vessels of water that represent the interrelations between supply and demand for different commodities. The equilibrium water level represents economic equilibrium (Tobin, 1987; Breslau, 2003). It is extremely interesting, that Fisher, did not think of this devise as an illustration, but believed in its direct relation to economic phenomena. As Breslau writes "There is nothing in either of these texts to indicate that the role of these mechanical models is any different from that of mathematical models, in making, and not simply illustrating, theoretical arguments". (Breslau, 2003, p.397). The close analogy is repeated in Fisher's *The Purchasing Power of Money*, where there is also another liquid dynamic model describing the monetary system. The model is used to demonstrate the economic principle that the value of the bullion and the currency will tend to equilibrium (Fisher, 1911, pp.112-148).

The vector mathematics of Fisher's professor Willard Gibbs, allowed for the commensuration of all demand, or indifference curves, in terms of homogeneous units of utility (Breslau, 2003, p.397). The following quotation provides the core of his methodological viewpoint.

> The introduction of mathematical method marks a stage of growth –perhaps it is not too extravagant to say , the entrance of political economy on a scientific era (Fisher, 1892 p., p. 85 or 1965, p.109).

Apart from the above general position, Fisher, promoted the specific mathematical tool of optimization under constraints, that was to become standard in economic modeling. As J. Tobin states: "On a remarkable range of topics, modern theorists adopt and build upon Fisherian ideas, sometimes unknowingly. Fisher's methodologies, not just his use of mathematics but his explicit formulations of problems as constrained optimizations, is the accepted style of present-day theorizing (Tobin, 1985, p.34)". This mathematical method was widely applied to problems in classical physics and especially classical mechanics.

Furthermore, a substantial number of pages in his most important work are devoted to demonstrate the direct analogies between economics and physics and especially mechanics. Fisher was convinced that terms from physics correspond to terms in economics thus supporting explicitly the analogy between economics and classical mechanics. He presents a list of terms that economists use and which have been employed from physics. Examples are: equilibrium, stability, elasticity, expansion, inflation , reaction, distribution (price), levels, movement, friction (Fisher, 1892, p.24). His next logical step is to construct a table of correspondence of terms and concepts between classical mechanics and economics.

In Mechanics		**In Economics**
A Particle	corresponds to	An Individual
Space	"	Commodity
Force	"	Marg. Ut. or Disutility
Work	"	Disutility
Energy	"	Utility
Work or Energy = Force x space …….	"	Disutility or utility = MU x commodity
Force is a vector (dir. in space)	"	MU is a vector (dir. in commodity)
Forces are added by vector addition.	"	MU are added by vector addition
Work and Energy are scalars	"	Disut. and ut. are scalars
Equilibrium will be where net energy is maximum	"	Equilibrium will be where gain is maximum

(Fisher, 1892, pp.85-86)

The above table of correspondence between economics and physics does not serve as a mere indication of similarities. For Fisher, the fundamental approach towards the analysis of economic phenomena should be based on these concepts. As Breslau points out: "In all of these areas (price formation, the monetary system, interest) Fisher proceeded by translating problems that had been understood in terms of differentiated social actors and goods, into terms of a mechanical system equilibrating a homogeneous substance (Breslau, 2003, p.399). For instance, in his discussion of the relationship between price, quantity and marginal utility, he uses the example of a cistern where the amount of liquid represents commodity and the distance of its surface from the top, its marginal utility (Fisher, 1892, p. 26).

The direct analogies between economics and classical physics are not confined to Fisher's most important work. In his subsequent *The Purchasing Power of Money*, he assigns the quantity theory of money the status of an exact physical law. As he writes:

> Practically, this proposition [the quantity theory of money] is an exact law of proportion, as exact and as fundamental in economic science as the exact law of proportion between pressure and density of gases in physics, assuming temperature to remain the same. (Fisher ,1911, p.320)

In the same manner, he repeats his conviction about the status of 'laws' in economics in his subsequent and probably, his most well-known work *The Theory of Interest*. He states:

> Rational and empirical laws in economics are thus analogous to rational and empirical laws of physics or astronomy. Just as we may consider the actual behaviour of the tides as a composite result of the rational Newtonian law of attraction of the moon and the empirical disturbances of continents, islands,

inlets, and so forth, so we may consider the actual behavior of the rates of interest in New York City as a composite of the rational laws of our second approximation and the empirical disturbances of Federal Reserve policy together with numberless other institutional, historical, legal, and practical factors. (Fisher, 1930, p.107).

In a discussion among prominent American economic theorists of the period, Fisher presented his views regarding the nature of the disciplines with such figures as H. J. Davenport, W. H. Hamilton, Richard T. Ely, and B. M.Anderson, Jr. This discussion which was published in the *American Economic Review*, the physics ideal is present and clear. As he writes:

> One of the speakers has said that economics is not physics. No, but its method is the method of physics, and I believe a study of physics to be one of the best preparations for a young man intending to enter economic theory. The trouble with economic theory is that economists have entered the field, either from the a priori side of philosophy and metaphysics where the proper importance of cold facts has not been recognized, or on the other hand, from the side of history where only facts and not principles have been studied. (Davenport et al , 1916, p.167).

Thus, in line with Edgeworth, Fisher’s work established a close connection between physics and economic concepts and furthermore, he introduced specific mathematical methods from classical physics to economics. These methods are widely used in contemporary economic theorizing. More importantly, he provided an extensive methodological justification for the physics analogy in economics. In this respect, his approach had a major influence to the development of orthodox economic methodological viewpoint.

IV. The Methodological Influence of Edgeworth and Fisher

The explicit references to the physics methodological ideal are not present in current economics. It seems that most orthodox economists are confident regarding the scientific status of the discipline in spite of the widespread criticism. Thus, they do not feel the need to refer to the analogies from physics for methodological justification. However, the physics methodological ideal heavily promoted by Edgeworth and Fisher, has exerted considerable influence on many crucial aspects of the discipline (see also Mirowski, 1989). In our view, there are three important features of current mainstream economics which are heavily connected with the adoption of the physics ideal. These three are: the mathematization of economics, the hostility towards methodological discussion and the negative attitude towards incorporating findings from other social sciences and especially from the related field of psychology.

1. The Mathematization of Economics

The close methodological analogies between economics and classical physics advocated by both Edgeworth and Fisher clearly facilitated the extensive use of mathematics in economic analysis. As was observed, the systematic use of mathematics was justified by both authors in terms of making economics more scientific in the manner of physics (see also Debreu, 1991; Turk, 2012).

Edgeworth's introduction and most importantly his methodological justification, of the calculus of variation (finding the maximum by using the signs of first second derivatives) is an indicative example in this respect. The use of Lagrange equations is another example of a mathematical method borrowed directly from classical mechanics. Furthermore, Fisher's doctoral thesis operated in the framework of Walrasian general equilibrium where he was able to apply the methods of vector calculus of his mentor, the physicist W. Gibbs. Fisher also explored in great detail, the mathematics of utility functions maximization (see also Tobin, 1985).

The subsequent use of these methods became standard especially after the publication of Samuelson's *Foundations*. Samuelson himself admits to this influence in an essay dealing with the intellectual development of his seminal work:

> I was vaccinated early on to understand that economics and physics could share the same formal theorems (Euler's theorem on homogeneous functions, Weierstrass's theorems on constrained maxima, Jacobi determinant identities underlying Le Chatelier reactions, etc.), while still not resting on the same empirical foundations and certainties (Samuelson 1998, p. 1376).

In the same conceptual framework, John von Neumann, who was very influential for the further development of formalism in economics, also advocated the use of the methods of physics to economic problems (von Neumann and Morgenstern 1944, pp.3-7; see also Rashid, 1994). It is indicative that von Neumann held that even the most advanced theoretical works in economic theory at the time, were seriously lacking in mathematical rigor in comparison to physics. As he writes in a letter to O. Morgenstern: "Economics is simply still a million miles away from the state in which an advanced science is, such as physics" (Morgenstern 1976: p. 810).

With above in mind, one can explain the widespread use of the specific mathematical tools found in most contemporary mainstream economics texts. In particular, the main analytical technique of constraint optimization (taken directly from classical mechanics) is preferred over other analytical mathematical methods such as input-output matrices or Markov chains (see also Mirowski, 1984). The almost universally used nowadays concept of utility, which for Edgeworth and Fisher corresponds to the classical notion of energy, can be viewed in the same framework, although a number of authors have shown that the concept is not necessary for most contemporary formulations (e.g. Wong, 1978). In general, the high degree of mathematization of contemporary mainstream economics has been the subject of much debate which focuses on the nature and method of the discipline (see for instance, Beed and Kane, 1991; Dow, 2012).

2. Aversion to Methodology

One can notice the contemporary view popular among many mainstream theorists that questions concerning the method of economics are not worthy. For instance, in a series of well-known writings, Frank Hahn argued that the study of economic methodology is irrelevant (e.g. Hahn, 1992). Caldwell (1993), Lawson (1994) and Backhouse (2010) among many others, have addressed this issue pointing out the anti-methodology stance of mainstream economics is widely accepted without serious arguments (see also Hoover, 1995). However, this hostility to economic methodology is not novel but goes back to Fisher:

> It has long seemed to me that students of the social sciences, especially sociology and economics, have spent too much time in discussing what they call methodology. I have usually felt that the man who essays to tell the rest of us how to solve knotty problems would be more convincing if first he proved out his alleged method by solving a few himself. Apparently those would-be authorities who are forever telling others how to get results do not get any important results themselves. (Fisher, 1932, p. 1).

A number of explanations regarding this negative attitude towards the study of economic methodology have been suggested. Ideological concerns, psychological motives, merely defensive responses through fear, or dislike, of criticism, the lack of any philosophical training, and sheer ignorance, are some of the reasons mentioned in the literature (see for instance, Lawson, 1994). The physics scientific ideal is also relevant in explaining the general hostility towards the study of economic methodology. The scientific prestige of physics and thus of the economics of Edgeworth and Fisher, makes methodological discussion and critique obsolete, in the sense that it shields economics from methodological attacks. Most mainstream economists are content with the methodological outline provided by Friedman's (1953) essay which effectively dismisses any methodological discourse concerning the role of assumptions in economics. It is indicative that in this essay, Friedman also uses the analogy of physical sciences in his effort to construct the methodological basis of positive economics:

> In short, positive economics is, or can be, an "objective" science, in precisely the same sense as any of the physical sciences. (Friedman, 1953, p.4)

Thus, the mainstream perception is that the high scientific status of economics deriving from its close analogies to physics, renders any methodological discussion obsolete. Although some methodologists argue that there are some signs of an increased interest to economic methodology (e.g. Wade Hands, 2001), aversion to such issues is still a feature of mainstream thinking.

3. Anti-Psychologism

Another consequence of the classical physics methodological ideal was the rejection of findings from other social sciences and especially from psychology. As was discussed, Edgeworth was in favor of incorporating psychological findings, but this stance should be seen in the context of his overall methodological perspective. More specifically, Edgeworth viewed psychological phenomena as a legitimate field for the application of mathematical tools. Thus, his willingness to link 'hedonic calculus' from psychophysics to utilitarian calculus in economics. On the contrary however, Fisher was clearly against the inclusion of psychological concepts in economics. As he writes in the beginning of his *Investigations*:

> To fix the idea of utility the economist should go no farther than is serviceable in explaining economic facts. It is not his province to build a theory of psychology (Fisher, 1892, p.11).

The differences in attitudes are due to the fact that Fisher thought of psychology as a 'soft' subject not worthy for consideration by the hard science of economics. In this sense, the following statement is indicative:

> But the economist need not envelope his own science in the hazes of ethics, psychology , biology and metaphysics (Fisher, 1892, p.23).

In the same conceptual tradition, Pareto believed that the construction of the fictional model of economic man was adequate for the needs of economic theory, thus clearly implying that psychological findings are not necessary (Pareto, 1971;see also Bruni and Guala, 2001; McLure, 2010). In more modern times, one of the main aims of Samuelson's revealed preference theory was to dismiss the alleged psychological concepts of utility theory (Samuelson, 1938, pp.61-62; Samuelson, 1947). This clearly indicates that a psychology-free economics was a very important methodological goal of Samuelson's work (see also Wong, 1978; Drakopoulos, 1997). During the same period, Hicks also attempts to construct a theory of choice without any reference to the subjective and psychological assumptions of marginalist utility theory. In his main work, *Value and Capital*, the aim of psychology-free economic theory is clear:

> In order to get clear-cut results in economic theory, we must work with concepts which are directly dependent on the individual's scale of preferences, not on any vaguer properties of his psychology (Hicks, 1939, p.177)

The dismissal of psychological findings was linked to the aim of the scientific character of economics. The rejection of all "metaphysical and psychological elements" was one of the main requirements for the establishment of the 'scientific' status of economics. An additional reason for the tendency to separate economics from other social sciences, including psychology, has to do with the perception of economics as the most advanced of the social sciences, and hence the one that is closest to the physical sciences (Seligman, 1969; Dow, 2002, pp. 170–175). The anti-psychologism bias of mainstream economics is also closely linked to the irrelevance of the assumptions thesis expressed in M. Friedman's (1953) well-known paper. The central idea here is that the realism of behavioural assumptions in economics does not matter as long as aggregate data behaves as if these assumptions were accurate (Friedman, 1953). This clearly implies that findings from psychology are not nor relevant for economics given that assumptions do not matter for the validity of the theory.

Thus, anti-psychologism as a widely accepted methodological position, provided a strong shield from criticism targeting the behavioural foundations of mainstream economics. Furthermore, it provided support for the pure 'economic' approach to human behaviour, which is seen as extremely successful and superior compared to other social sciences (for a detailed account of the uneasy relationship between mainstream economics and psychology, see Lewin, 1996; Rabin, 2002).

VI Concluding Comments

Although analogies between economics and physics can be found in a number of classical and marginalist authors, Edgeworth's and Fisher's works represent the highest point of classical physics imitation. These two influential economists transferred important terms and concepts from classical physics to economics. In addition, they provided the methodological grounding for the adoption of the physics scientific ideal in mainstream economics. This scientific ideal was extremely influential for the formation of current mainstream economics thinking as was seen through the works of Samuelson, Friedman, von Neumann and others. It was also seen that there were important consequences of this methodological stance which are the following: 1) the physics ideal meant that economics should adopt the established mathematical methods from physics. This was one of the most important reasons for the increased mathematization of economic theory. 2) The status of mainstream economics as a 'hard' science led to the relegation of the methodological discussion concerning the status of orthodox theory. Furthermore, the anti-methodology stance shields mainstream economics from heterodox attacks. 3) The 'hard' science status also implies that economics does not need to adopt findings, concepts, or generally ideas from other 'soft' social fields like psychology.

In general, the arguments presented in the paper might contribute to the better understanding of the role of the physics scientific ideal in shaping important elements of contemporary mainstream economic theorizing. The discussion might also contribute to the methodological debate concerning the role of the scientific ideal in mainstream economics.

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