Price Theory as Physics: The Cartesian Influence in Walras

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Leon Walras was subject to many intellectual influences. In philosophy and methodology he was subject to a particularly rich and heterogeneous set of influences. The "eclectic" philosophers who dominated official philosophical circles in the France of Walras's youth took themselves to be "synthesizing" the work of just about all past philosophers. Plato, Aristotle, Descartes, Kant, Reid, and Spinoza were all subject to the various integrations and syntheses of the different "eclectics". And they are all mentioned in Walras's work. (See, e.g., Walras 1936) This paper takes a first step at sorting out these philosophical influences.

In this paper I will argue that certain features of Walras's thought are derived, directly or indirectly, from the writings of Rene Descartes. (William Jaffé [1983, pp. 102-3], Emil Kauder [1965, p. 14], and Joseph Schumpeter [1951, p. 75] all report that Walras was influenced by Descartes, but they do not elaborate.) I will argue further that these features of Walras's philosophical thought help to explain certain features of his economic thought. Specifically, I will claim that Walras's Cartesian ontology led him to construct a mechanistic price theory and to consider his theory a branch of Cartesian physics and that his Cartesian epistemology led him to construct an equilibrium theory which is difficult to test empirically. Section one argues that Walras was a (vigorous) Cartesian justificationist. Section two reviews Walras's epistemology and shows its similarity to that of Descartes. Section three shows that Walras's ontology was Cartesian dualism. Section four discusses the relation of these Cartesian foundations to general equilibrium theory proper. Section five argues that some characteristic features of Walras's theory derive in part from the Cartesian elements in his thought. Section six discusses some possible implications for current economic analysis.

1. Walras as Cartesian Justificationist

Walras as and Descartes were vigorous justificationists. Justificationists abhor the unsubstantiated conjecture; they wish to ensure the veracity of science by officially withholding their assent from any proposition not securely based on proper foundations. No proposition may emerge from the dark ocean of conjecture and speculation until it has been justified, whether by deduction, induction or other means. For Descartes and Walras, to justify a proposition is to establish its certainty by means of a proof. [1, 2]

Now a proof is only as good as its premises. I cannot claim to have proved any scientific proposition unless I can claim to have proved the premises of my science. Thus, before constructing scientific proofs, I must justify the premises of my science. These proofs, in turn, rest on premises derived from the general philosophy of science. But, in order to justify the premises of the general philosophy of science, I must justify the metaphysical propositions they are based on. And so it goes. Luckily, we can find in metaphysics undoubtable propositions which serve as the ultimate premises of all later deductions.[3] These are the fundamental axioms from which one derives all knowledge, *a la mode geometrique*.[4]

Descartes explained his conception of the structure of human knowledge by comparing philosophy to a tree, "of which the roots are Metaphysics, the trunk is Physics, and the branches emerging from this trunk are all the other branches of knowledge." [Descartes, 1983, p. xxiv] Thus, if we wish to acquire useful, practical knowledge, it is necessary to begin with metaphysics and proceed by rigorous deduction to the construction of physics. From physics we proceed by further deductions to the principles of, say, harmonics and stress analysis. The fruit of our efforts comes when harmonics and stress analysis (in our example) are applied to the construction of, say, suspension bridges such as the Golden Gate Bridge, or the Tacoma Narrows Bridge. "Now, just as it is not from the trunk of trees that one gathers fruit, but only from the extremities of their branches, so the principal usefulness of Philosophy depends upon the parts of it which can only be learned last." [*ibid.*]

Walras understood this perfectly. When he asks, "Is it, or is it not worthwhile to demonstrate rigorously the fundamental laws of science?" [Walras, 1954, p. 471] We know the answer:

By demonstrating rigorously first the

> elementary theorems of geometry and algebra, and then the resulting theorems of the calculus and mechanics, in order to apply them to experimental data, we have achieved the marvels of modern industry. Let us follow the same procedure in economics, and, without doubt, we shall eventually succeed in having the same control over the nature of things in the economic and social order as we already have in the physical and industrial order. [Walras, 1954, p. 471]

This is not so much hot air. Walras did not seize the Cartesian program *post hoc* and staple it to the front of an independently created theory. Evidence to this effect can be found in his letter to Adolph Gueroult, the editor of *La Presse*. In 1859, less than a year after promising his father he would devote himself to economics, Walras wrote to Gueroult seeking, "a Review, a Journal in which to develop scientific truths." [Walras, 1965, p. 35] In this letter, Walras explains his plan for a "scientific solution" to "the Problem of the Distribution of Wealth" which would be "for social science what the laws of Kepler have been for astronomy. [*ibid.*]

First, metaphysics must be investigated without appeal to religious prejudice. The "Theory of Reality" will then serve as the basis of a general "Theory of Science."[5] [Walras, 1954, p. 36] Second, "the general Philosophy of Science" will serve as foundation for "the Philosophy of Political Economy." Indeed, this is an "urgent" matter which has been left as yet undone. [*ibid.*] Walras then goes on to describe the general features of a correct philosophy of economics. The system he describes is close to that of the *Elements*. This holds also for those more or less technical propositions of economics which he describes for Gueroult. "At this point of development," says Walras, "the solution to the social problem would present itself armed with all of the natural and moral, *a priori* metaphysical proofs." All of this comes from the pen of a 24 year-old hack novelist whose commitment to social science is not yet a year old.[6] At this point, Walras had not even completed his earliest efforts in mathematical economics, efforts which Jaffe describes as "pathetic ... giving not the slightest inkling of what was ... to follow." [Jaffé, 1983, p. 22]

Having made virtually no progress in economics proper, Walras views the execution of his program as an "enormous work" leading to an entirely original solution of the social problem, but requiring, perhaps, the cooperation of "a generation of publicists." [Walras, 1965, pp. 35-6] Walras expresses here the very sentiments Descartes had expressed in the *Discourse*, namely, that his method would lead to "conclusions of great usefulness in life," but only through "the combined lifetimes and labors of many scholars" working in succession. [Descartes, 1971, pp. 46-7]

The letter to Gueroult shows that the Cartesian elements in Walras's program were not *ex post* justifications or expositional devices. Not only in exposition, but in literal fact, Walras began with metaphysics, proceeded from there to the philosophy of science and thence to the philosophy of political economy. Only after this had been done did he apply himself seriously to economics proper. (Even in his stated preference for the ivory tower existence of the academic, Walras was following the tentative moral code Descartes had set for himself in his youth. See, *Discourse* part I.)

The Cartesian brand of justificationism is merciless. To discredit a theory, one need only find fault with its philosophical foundations. From this point of view, it is natural to begin any scholarly treatise with an attack on past results in the field, an attack leveled against the foundations only. This is how Descartes began his *Discourse on the Method*. Similarly, Walras began the *Elements* with a harsh review of previous formulations of political economy. In his critique of earlier theorists, Walras did not address the specific content of their theories, but only their definitions of political economy and the putative philosophical foundations of their systems. In so doing, Walras followed the Cartesian pattern. To refute the theories of earlier practitioners, Descartes wrote, "will not mean going over each of them — an unending task; when the foundation is undermined, the superstructure will collapse of itself; so I will proceed at once to attack the very principles on which my former beliefs rested." [Descartes, 1971, p. 16] Walras, in his turn, concludes his attack on past efforts in economics by saying,

> This is the sort of political economy that is being fashioned and taught today. Is that not reason enough to hold that the structure is cracked and the facade deceptive and that in such a case it is the right and primary duty of the economist carefully to formulate the philosophy of his science? [Walras, 1954, p. 56]

2. Walras and the Cartesian Epistemology

The geometric method can have no special claim on our attention unless ultimate premises are certain, and logical deduction is foolproof. Any measure of doubt attending the premises will be

sent directly to the conclusions. In this case the conclusions can hardly be said to have been "proved" at all. Matters are made worse if the process of logical deduction is not itself fully guaranteed to transfer all truth faithfully and flawlessly from premise to conclusion. If there be any slips along the way, who knows what madness might pass for justified truth?

Cartesian justificationism, then, can have no truck with fallibilism. It requires perfection. If our ideas are not perfect, they may be doubted. If they may be doubted, they are not certain, they have not been proved, they are not justified, they are but froth and water in the great ocean of conjecture and speculation. But perfection is an exacting requirement for mortals. Is it any wonder, then, that Descartes would hold that, "the certainty and truth of all knowledge depends entirely on my awareness of the true God"? [Descartes, 1971, p. 108] Descartes understood clearly that only the goodness of a perfect God can ensure the veracity of the geometric method.[7] This not withstanding, Descartes had other and in a way more fundamental reasons to uphold the veracity of reason.[8] They may be analyzed in terms of three related elements deployed by Descartes to ensure the certainty of his metaphysical premises and the flawlessness of logical deduction. Each of these is reviewed below and the extent to which Walras accepted the principle or doctrine involved is discussed. It will be found that Walras placed enough credence in them to end up asserting that reason is "infallible," even though he did not make Descartes' appeal to God's goodness. The first element is the principle of clear and distinct ideas. This principle directs us,

> never to accept anything as true if [we have] not evidence of its being so; that is, carefully to avoid precipetancy and prejudice, and to embrace in [our] judgement only what presents itself to the mind so clearly and distinctly that [we have] no occasion to doubt it. [Descartes, 1971, p. 20]

Descartes took this as an axiom: "Whatever I perceive clearly and distinctly is true."[9] [Descartes, 1971, p. 76] And it was only his prior acceptance of this axiom that allowed him to view the *cogito* (I think, therefore I am) as a secure and certain foundation for all knowledge. To be sure, the *cogito* is *psychologically* prior to the principle of clear and distinct ideas, but this latter is *logically* prior to the *cogito*.

By cleaving to the principle of clear and distinct ideas, one can, putatively, achieve results which are true, definitive and certain. Walras explicitly credits this principle in a letter to Edouard Pfeiffer penned in 1874 — the same year the first installment of the *Elements* was published: "Not only do I esteem with Descartes that only that which is evident can be considered as true, but I esteem further that only that can be regarded as impossibie which is evidently absurd." [Jaffé, 1983, p. 28] (Descartes seems to have accepted the latter principle as well. See, [Descartes, 1971, p. 295]. It seems, moreover, that Walras understood the role which this principle plays in the Cartesian program, for he called it, "the generator of scientific and political progress." [Walras, 1965, p. 373])

This brings us to the second element in Descartes' defense of the possibility of certainty, his theory of errors. To say that clear and distinct ideas never fail is tantamount to saying, as Descartes did, that "the intellect contains, properly speaking, no error." [Descartes, 1971, p. 95] Walras did not miss the point. He too averred that reason is "infallible." [Walker, 1984, p. 452] But if reason is infallible, if the intellect is perfect, how is error possible? "Surely," says Descartes, "just from this: my will extends more widely than my understanding, and yet I do not restrain it within the same bounds, but apply it to what I do not understand." [Descartes, 1971, pp. 96-7] There is something inevitable about this answer. Descartes has already concluded that by assenting to clear and distinct ideas we will certainly be delivered from error into truth. It is virtual corollary to claim that error arises from assenting to ideas which are not entirely clear and distinct. This view attributes error to a blameful misapplication of the will. It identifies prejudice as a leading cause of error. [Descartes, 1983, pp. 32-3; 1971, p. 23 and p. 106]

The precise extent to which Walras accepted the Cartesian theory of error may be doubted, but it is clear that Walras did accept that proper application of the will leads to truth. Walras argued, for instance, that it is possible to "demonstrate" the "fundamental questions" of bimetallism, "given the will to do so." [Walras, 1954, p. 338] Presumably, then, only a misapplication of the will could lead one into error. Walras says also that "only a moment's reflection is necessary to convince anyone free from sectarian prejudice" that the theory of exchange is science while the theory of production is art. [Walras, 1954, p. 60] And in his letter to Gueroult he identifies religious prejudice as an obstacle to "the progress of social ideas." [Walras, 1965, p. 36] So he seems to have placed some

stock in the Cartesian view of prejudice as a leading cause of error. Sometimes, Walras seems to be simply baffled by error. (See his comments on Garnier [Walras, 1954, p. 56] and Coquelin. [Walras, 1954, p. 59]) Indeed, if reason is infallible, there is something mysterious about error!

The third element in Descartes' defense of certainty concerns the reality of universals. In order to square the principle of clear and distinct ideas with the possibility of empirical science, Descartes asserted that "even bodies are not really perceived by the senses or the imaginative faculty, but only by intellect." [Descartes, 1971, p. 75] Thus it is the intellect's clear and distinct conceptions which give us information on extended stuff (*res extensa*). The clouded content of our sensations are but occasions for the "summoning up" of those "innate ideas" which concern nature. [Descartes, 1911b, p. 73] In Platonic fashion, Descartes esteems the philosopher's reality of number and geometric figure above the idiosyncratic and ephemeral world of experience.

> ...Corporeal things exist. However, they are perhaps not exactly what we perceive by the senses, since this comprehension by the senses is in many instances very obscure and confused; but we must at least admit that all things which I conceive in them clearly and distinctly, that is to say, all things which speaking generally, are comprehended in the object of pure mathematics, are truly to be recognized as external objects. [Descartes, 1911a, p. 191]

Leon Walras held a similar view of universals. "Science," he says' "does not study corporeal entities but universals of which these entities are manifestations." [Walras, 1954, p. 61] Like Descartes, Walras thought that it was our experience of these "manifestations" which stimulates us to conceive of and define their underlying universals. [Walras, 1954, p. 71]

One important difference between the Cartesian and Walrasian views of universals must be noted. Descartes held that it is possible to reason from the idea of an object containing "perfections" to the existence of the object. (See Descartes, 1911a, p. 180; 1911b, pp. 226-9; and the sixth *Meditation.*) For Descartes, "existence is a perfection." [Descartes, 1971, p. 105] Thus, when Descartes says, "there cannot be in us any idea or image of any thing of which there does not exist somewhere (either in us or outside us) some Original which truly contains all its perfections," [Descartes, 1983, p. 10] we can be sure that the "Original" is the real thing. Walras rejected this mode of inference. Following the French philosopher Etienne Vacherot, Walras held that the real is necessarily imperfect and the perfect is necessarily ideal and thus unreal (Walras 1936, pp. 10-11). Thus, even though Walras accords universals the same *scientific* status given them by Descartes and even though he agrees with Descartes that the universals studied by science are *perfect*, Walras did not accept the doctrine that these universals are *real.* (See Koppl 1989 for a discussion of the influence of Vacherot on Walras's thought.)

3. Walras Accepts the Cartesian Ontology

We have seen that Walras accepted the Cartesian program of justifying all knowledge through proofs which establish certainty. This alone is an important Cartesian influence. Walras also accepted Descartes' dualistic ontology. He deployed a Cartesian "enumeration" in order to reach precisely the dualist position.

When Walras takes up the question of the nature, divisions and scope of political economy, he cannot accept tentative and partial conclusions. The "empirical" and "arbitrary" answers with which economists have heretofore been satisfied will not do. "Let us, on our side, not overlook anything. Let us take up the whole question in its entirety and follow the distinction through rationally, completely and definitively." [Walras, 1954, p. 60] As we have seen, this means sketching first a general philosophy of science. Without a general philosophy of science as foundation, the particular philosophy of economics cannot be properly formulated. To this end it is necessary to engage in a classificatory enterprise. And of course it is universals that are to be classified. After all, "Corporeal entities come and go, but universals remain forever. Universals, their relations, and their laws, are the object of all scientific study. Moreover, the various sciences can differ only with respect to their subject matter, or the facts they study. Thus, in order to classify sciences, we must classify facts." [Walras, 1954, p. 61] In so saying, Walras is in perfect conformity with the seventh of Descartes' Rules for the Direction of the Mind. This rule states that,

> If we wish our science to be complete, those matters which promote the end we have in view must one and all be scrutinized by a movement of thought which is continuous and nowhere interrupted; they must also be included in an enumeration which is both adequate and methodical.[10] [Descartes, 1911a, p. 19]

By "enumeration" Descartes means not only a careful listing of each step in a deductive proof,

but also "a review or inventory of all those matters that have a bearing on the problem raised, which is so thorough and accurate that by its means we can clearly and with confidence conclude that we have omitted nothing by mistake." [*ibid.*] The particular enumeration employed will depend on the problem at hand. For example, "if I wish to prove that the rational soul is not corporeal, I do not need a complete enumeration; it will be sufficient to include all bodies in certain collections in such a way as to be able to demonstrate that the rational soul has nothing to do with any of these." [*ibid.*] This is the pertinent example, for it is the distinction between mind and matter which Walras places at the center of his philosophy of science. After the last quoted passage of the *Elements,* Walras states, "Now, the first point to notice is that we may divide the facts of our universe into two great categories: those which result from the play of the blind and ineluctable forces of nature and those which result from the exercise of the human will, a force that is free and cognitive." [Walras, 1954, p. 61]

Just as the facts of the universe fall into two mutually exclusive categories, the objects of the world fall into two distinct categories, "persons" and "things". Says Walras, "The fact that man's will is cognitive and free makes it possible to divide every entity in the universe into two great classes: *persons* and *things*. ...Man alone is a person; minerals, plants and animals are things." [Walras, 1954, p. 62] Walras, in fact, compares animals to "pure mechanism[s]" [Walras, 1954, p. 62] just as Descartes before him had identified animals as "automata."

Facts resulting from the blind and ineluctable forces of nature concern the relations of things to things. Facts resulting from the free and cognitive human will concern either the relations of persons to things or the relations of persons to persons.

Walras identified four distinct types of systematic inquiry: history, art, ethics and science. We have in the first instance history. Man's past may be studied, the record of his previous glories and follies may be systematically scrutinized. The three other classes of inquiry emerge from elementary combinatorics. There are two sorts of objects in the world, persons and things, consequently there are but three logically possible relations between objects: the relations between things and things, the relations between things and persons, and the relations between persons and persons. These relations constitute the domains of nature, industry, and institutions and are studied by science, art, and ethics. "Such, then, are the distinguishing characteristics of science, art and ethics. Their respective *criteria* are the *true*; the *useful*, meaning material well-being; and the *good*, meaning justice."[11] [Walras, 1954, p. 64]

Here is Cartesian dualism in an almost pure form. Walras's distinction between science, art, and ethics is close to Descartes' distinction between Physics, Medicine and Mechanics, and Ethics. Descartes' "Physics" is clearly the very same thing as Walras's "science properly speaking." What Descartes called "Medicine and Mechanics" seems to correspond to what Walras calls "art". Finally, of course, both distinguish the field of ethics. The ontology, is pure Descartes. What Walras calls "things" is precisely Descartes' extended stuff, and what Walras calls "persons" is precisely Descartes' thinking stuff (*res cogitans*). The results of Walras's "definitive" treatment of the philosophy of science may be summarized in Table 1.

Table 1

	Persons	Things
Persons	Free and cognitive human will is present.	Both the free and cognitive human will are present.
	Phenomena are human.	Phenomena are human.
	Domain is that of institutions.	Domain is that of industry.
	Studied by ethics using criterion of the good.	Studied by art using criterion of the useful.
Things		Blind and ineluctable forces of nature are present.
		Phenomena are natural.
		Studied by science using criterion of the true.

The row acts on the column. Each quadrant of the table describes the relations of the entities in the column to the entities in the row.

4. The Philosophy Applied to Society

If science studies only the relations of things to things, if human phenomena cannot be studied scientifically, then political economy cannot be scientific in any of its branches. But is not Walras, as Schumpeter [1954, p. 827] held, the greatest of

economic theorists? Was Jaffé right to see general equilibrium theory as a normative scheme only pretending to be scientific? As we shall see, Walras did manage to construe one branch of political economy as a science.

According to Walras, political economy is the study of social wealth. Social wealth gives rise to three "generic phenomena" which must be studied from three distinct points of view: value in exchange, industry, and property. [Walras, 1954, pp. 65-8] To each of these three generic phenomena there corresponds a distinct branch of political economy, the first a science, the second an art, and the third a branch of ethics. Value in exchange is studied by pure economics, a science. Industry is studied by applied economics, an art. Property is studied by social economics, a part of ethics.

Social economics, to pick things up in reverse order, studies those relations between persons and persons which are a direct consequence of scarcity. It is a branch of ethics and property is its object of inquiry. Social economics, the "science of the distribution of wealth" as Walras [1954, p. 79] sometimes calls it, "has for its object to render to each what is properly his," it "espouses justice as its guiding principle." [*ibld.*] The "science" of distribution is not, of course a science "properly speaking." There can be nothing like natural laws governing the distribution of wealth, only the dictates of moral reasoning:

> The appropriation of scarce things or of social wealth is a phenomenon of human contrivance and not a natural phenomenon. It has its origins in the exercise of the 1 human will and in human behavioi and not in the play of natural forces. [Walras, 1954, p. 76]

Walras puts distributional questions in the realm of ethics where purely scientific considerations cannot enter. From this point of view, any schemes for redistribution or for reforms in the law of property which are demanded by *a priori* lucubrations over "justice" cannot be countered by any possible objections arising from theoretical social science.

> ...[O]nce the conditions of appropriation are fulfilled in the nature of things, it is within our power to determine whether this appropriation shall be carried on in one way rather than in another. Obviously, this power does not reside in each of us individually but in all of us taken collectively.[12] We are dealing here with a human phenomenon that is shaped, not by the separate will of each individual, but by the collective activity of society as a whole ...while nature makes things appropriable, mankind determines and carries out the appropriation.
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> Moreover, the appropriation of things by persons or the distribution of social wealth among men in society is a moral and not an industrial or natural phenomenon. It is a relationship among persons. [Walras, 1954, pp. 76-7]

Industry gives rise to two classes of operations, "technical operations" and "the economic organization of industry." [Walras, 1954, pp. 73-4] In tandem are the technical arts and "applied economics," together constituting the applied sciences. They study the relations between persons and things. The phenomenon of the division of labor falls under this branch of study:

> It is absolutely impossible for us ... to include the question of the production of social wealth, any more than the question of its distribution, within the scope of natural science. The will of man is free to influence the production, as well as the distribution, of social wealth. The only difference is that in distribution, man's will is guided by considerations of justice, whereas in production his will is guided by considerations of material well-being. [Walras, 1954, p. 75]
>
> Thus, the theory of the economic production of social wealth, that is, of the organization of industry under a system of the division of labor, is an applied science. For this reason we shall call it *applied economics*. [Walras, 1954, p. 76]

Under the traditional division, political economy is the study of the consumption, distribution and production of wealth. Walras places both the distribution and the production of wealth within the realm of normative economics. By means of an elegant Cartesian "enumeration," Walras has withdrawn from scientific scrutiny the operations of the division of labor (this being a subject for applied economics) and all social institutions thought to be "unintended" by the critical rationalists (these being subjects for social economics). The normative disciplines which treat of these phenomena are to be constructed *a priori, a la mode geometrique.*

> The theory of property defines the mutual relations established between man and man with respect to the appropriation of social wealth, and determines the conditions of the equitable distribution of social wealth

> within a community. In this connection, men are considered in the capacity of moral personalities. The theory of industry, on the other hand, defines those relations between man and things which aim at the increase and transformation of social wealth, and determines the conditions of an abundant production of social wealth within a community. Here men are considered in the capacity of specialized workers. The conditions determined by the theory of property are moral conditions deducible from the premise of justice; while those determined by the theory of industry are economic conditions deducible from the premise of material welfare. In the one case as in the other we are dealing with guiding principles for the organization of society. [Walras, 1954, p. 79]

The "pure theory of economics" studies value in exchange and is one of the natural sciences; it is a branch of physics. That Walras would construe the theory of value in exchange, general equilibrium theory, as a natural science is surprising; that he does so successfully, i.e. without contradicting himself, is perhaps more surprising. Walras achieves this result by viewing value in exchange as a relation existing between things and things prior to any actual act of exchange.

> Once all things that can be appropriated (that is, all I scarce things and nothing else) have been appropriated, I they stand in a certain relationship to each other, a relationship which stems from the fact that each scarce thing, in addition to its own specific utility, I acquires a special property, namely, that of being exchangeable against any other scarce thing in such and such a determinate ratio. [Walras, 1954, p. 67]

Value in exchange is not *in* exchange at all, it is the property of being exchange*able* in a determinate ratio. This property inheres in the object and obtains quite independently of any actual exchange; it obtains, "once all things ... have been appropriated" and not once all (or any) exchanges have taken place. The phenomena of value in exchange are natural phenomena of consisting relations between things and things. The theory of value in exchange is called the pure theory of economics, "and this pure theory of economics is a science which resembles the physico-mathematical sciences in every respect." [Walras, 1954, p. 71]

Price theory is physics. This was true for Walras in two senses. First, he thought the mathematical structure of general equilibrium theory identical to the "Newtonian" physics of his time. I will return to this point later. Second, price theory studies material things, the relations of things and things; it does not study the relations of persons and things or of persons and persons. Price theory occupies the same place in the tree of knowledge as Descartes' physics.

As Philip Mirowski says in an acute if compressed discussion of this point.

> [Walras] does not mean that people have no willful influence on price; in this respect, he compares competitive prices to the law of gravity, which we can resist at will, but we cannot alter the essence of the law. It is in this restricted sense that his pure economic theory is "the theory of the determination of prices under a hypothetical regime of perfectly free competition." [Walras, 1954, p. 40] These prices are natural since they cannot be manipulated by human will away from their natural state. [Mirowsk, 1981, p. 595]

Walras explicitly denies that his theory predicts human decisions. To the objection that the free will makes unpredictable decisions he responds,

> Actually, we have never attempted to predict decisions made under conditions of perfect freedom; we have only tried to express the effects of such decisions in terms of mathematics. In our theory each trader may be assumed to determine his own utility or want curves as he pleases. Once these curves have been determined, we show how prices result from them under a hypothetical regime of absolutely free competition. [Walras, 1954, p. 256]

There is an interesting parallel between this argument of Walras and an argument Descartes made in the *Principles* . Descartes argued that the phenomena of the corporeal world (*res extensa*) should be explained without appeal to God's action except as the first cause of motion, a cause operating in the strictly hypothetical realm of a homogeneous plenum.[13] [Descartes, 1984a, pp. 256-7] Similarly, Walras argued that the phenomena of value in exchange should be explained without appeal to man's action except as the chooser of utility curves, curves operating (mechanically) in the strictly hypothetical realm of absolutely free competition. The parallel may be coincidental, but there is some reason to suspect a deeper connection.

According to Jaffé [1983, p. 288-325] Walras struggled for years to find a precise meaning for his father's idea that "scarcity (*rareté*) is the cause

of value." He succeeded only when Paul Piccard, a professor of mechanics at Lausanne, showed him how to derive a demand curve from a utility function and a budget constraint. Walras borrowed his father's definition of scarce things as things useful but limited in quantity and his father's formula for the "cause of value" and labored for years to relate them to a mechanical system of demand and supply. "Leon Walras was eager to solve the problem," according to Jaffé, "not only out of filial piety, but because the conceptual machine he had already designed for the determination of equilibrium prices needed a motor to run it." [Jaffé, 1983, p. 315] Walras, in other words, needed a *primum mobile* to set his system in motion.

One might argue that the way Walras introduced utility into his system was a function of his attempt to imitate astronomy and mechanics, and not a question of metaphysics at all. That Walras was attempting to carry out a slavish imitation of the methods of physics can hardly be doubted. "The true *fons et origo* of Walras's multiequational formulation of general equilibrium," according to Jaffé, "was Louis Poinsot's once famous textbook in pure mechanics, *Elements de Statique* (1803), which, as Walras confided to a friend in 1901, he first read at age of 19 and then kept by him as a companion book throughout his life." [1983, p. 132] And it is possible that Walras's long search for a mathematically precise meaning for his father's idea that "scarcity is the cause of value," has no deeper roots than a desire to perfect the analogies between economics on the one hand and mechanics and astronomy on the other hand. Under this supposition, the parallel between Descartes' treatment of motion in physics as a product of Divine will and Walras's treatment of value in price theory as a product of human will is coincidental. But this supposition ignores the importance Leon Walras attached to his father's thesis.

The thesis that scarcity, the combination of utility and limitation in quantity, is the cause of value figures prominently in Leon Walras's "Theorie Generale de la Societe" [1936, pp. 25-202] This essay was written in the years 1867 and 1868, a full four years before Piccard showed him how to drive his system. [Jaffé 1983, p. 81] In it, Walras uses the idea that scarcity is the cause of value in order to immunize the propositions of pure and applied economics from the moral critique of "spiritualism". (If we suppose that value results not from the combination of utility and limitation of quantity, but from the efforts, services, and toil of man, Walras argues, then we see "as if by magic" [*comme par echantement*], the individualistic conclusions of materialism transformed into the collectivistic conclusions of spiritualism. [Walras, 1936, p. 85] This maneuver was part of a more elaborate campaign to reconcile spiritualism, socialism, and collectivism with materialism, liberalism, and individualism. The first group of ideas is formed on the conception of man as a rational and free soul whose actions are guided by morality. Under this view justice is the principle of social order. [Walras, 1936, p. 86] These ideas have their proper application in the domain of social economics, but only after they have been rehabilitated through the critique of interior experience (*critique del experience intime*) provided by modern rationalism. [1936, pp. 88-90] The second group of ideas is formed on the conception of man as an organized body whose actions are guided by utility. Under this view (material) interest is the principle of social order. [Walras, 1936, p. 86] These ideas have there proper application in the domain of applied economics, but only after they have been rehabilitated through the critique of exterior experience provided by modern science. [Walras, 1936, pp. 82-3, 86-7] Neither body of ideas is a theory of the " natural laws of *value in exchange* and of *exchange*." [Walras, 1936, p. 30] "Pure political economy" is a science "absolutely independent" of all considerations of utility and justice, which considerations bear only on social and applied economics. [Walras, 1936, p. 30-31]

Walras thought that his reconciliation of spiritualism, socialism, and collectivism with materialism, liberalism, and individualism depended crucially on his definition of scarcity and the identification of scarcity as the cause of value. He argued that the divergence between the liberal and socialist schools of thought hinged "on the question of the nature of social wealth and the origin of value in exchange, and on the question of the basis of the right of property." [Walras, 1936, p. 31]

Thus, the peculiar way in which in Walras relates the free and cognitive human will to the natural phenomena of value in exchange seems to be more than the consequence of an urge to imitate the physics of his time. It seems to have been an integral feature of his social philosophy and of his metaphysics.

If it is true that Walras saw a parallel between utility as a manifestation of human will and motion as a manifestation of Divine will, then his effort to construct economics as an imitation of physics had a more powerful motive than the free-floating thought that such an analogy might be fruitful..

In any event, the freedom with which individuals may choose their utility curves does

not in any way alter the mechanical character of price determination under free competition. The phenomenon of value in exchange is a natural phenomenon and not a human phenomenon. "It is said," Walras writes, "we cannot command nature except by obeying her. This applies also to value." We can influence price by acting on the natural conditions of value, for example destroying some part of the wheat supply. "It would even be possible, in an extreme case, to abolish value altogether by abolishing exchange. If, however, exchanges do take place, *we cannot prevent them* from giving rise to or tending to give rise to certain exchange values, naturally under given conditions of supply and demand, in short, of scarcity." [Walras, 1954 p. 69, emphasis added]

> The law of supply and demand regulates all these exchanges of commodities just as the law of universal , gravitation regulates the movements of all celestial I bodies. Thus the system of the economic universe reveals itself at last, in all its grandeur and complexity: a system at once vast and simple, which for sheer beauty resembles the astronomic universe. [Walras, 1954, p. 374]

Walras called this analogy between economics and astronomy "complete and striking." [Walras, 1965, p. 119] The analogy is striking indeed. No sense of obligation prods the sun into rising each morning. No expectation of profit keeps the Moon in her place. Stars neither twinkle for joy not burn in anger. No sense of purpose or plan of action guides the heavenly bodies, only the blind and ineluctable forces of nature.

We saw earlier that Walras's letter to Gueroult showed him to have from the start a clear conception of the philosophical framework for his system. Now that we have examined his application of this philosophy to economics, another letter is of interest to us, his letter to Jules du Mesnil-Marigny, penned in 1862. In this letter, Walras proposed collaboration on a book, "with Walras doing all the writing and with du Mesnil-Marigny paying all the bills, allotting Walras a stipend besides." [Jaffé, 1983, p. 80] The letter contained a table of contents for the work, which was to be called *Traite complete d'economie politique et sociale*. Book I would contain an exposition of the pure theory of economics. Book II would contain an exposition of applied economics, which would include a treatment of the division of labor, of credit and financial institutions, and of speculation. Book III would contain an exposition of social economics, which would include a treatment of property and taxation. Finally, Book IV would contain a history of political economy beginning with the Physiocrats and ending with a critique of "le socialisme empririque." The introduction would explain the three-fold division of political economy and how its "triple point of view — of the *True*, the *Useful* and the *Just* — embraces in one synthesis and one rigorous analysis, all economic and social phenomena and principles." [Walras, 1965, p. 120]

The scientific part of *Traite*, Book I, would be an "original creation," a "new science ... the science of economic forces analogous to the science of astronomic forces." "Facts of nature," Walras informs Mesnil, "are and remain superior to social conventions, and they impose themselves on the human will." Moreover, they, "admit of a fruitful application of mathematical calculations and formulae." [*ibid.*, pp. 119-20]

Here again we see that, at a time when Walras had made virtually no progress toward the completion of his theoretical structure, he had a clear and distinct conception of its characteristic features and of its philosophical framework. Descartes intended his method to be "the true method of *attaining* knowledge." [Descartes, 1984a, p. 119, emphasis added] As his letters to Gueroult and Mesnil show, Walras followed this method, working out first the philosophy of science on the basis of ontology, and turning to the construction of economic theory itself only at a later point in time.

5. Some Implications

The fact that the theory of value in exchange is a branch of Cartesian physics explains many of its characteristic features. I will mention three. The mechanistic character of general equilibrium theory has already been discussed. There is nothing like "*verstehen*" or "free will" or "agency" in general equilibrium theory. And this is by design. Walras's Cartesian ontology led him to construct price theory as physics.

The second feature of general equilibrium theory which commands our attention is Walras's use of the "rational method" of the "physico-mathematical sciences."

> From real type concepts, these sciences abstract ideal-type concepts which they define, and then on the basis of these definitions they construct a *priori* the whole framework of their theorems and proofs. After that they go back to experience not to confirm but to apply their conclusions. Everyone who has studied any geometry at all knows perfectly well that ... reality confirms these definitions and

> demonstrations only approximately and yet reality admits of a very wide and fruitful application of these propositions. Following this same procedure, the pure theory of economics ought to take over from experience certain type concepts, like those of exchange, supply, demand, market, capital, income, productive services and products. From these real-type concepts the pure science of economics should then abstract and define ideal-type concepts in terms of which it carries on its reasoning. The return to reality should not take place until the science is completed and then only with a view to practical applications. Thus in an ideal market we have ideal prices which stand in an exact relation to an ideal demand and supply. And so on. [Walras, 1954. p. 71]

These "ideal-type" concepts are the universals which we saw Walras refer to earlier. Having once abstracted the universals studied by any science, one derives the theorems of this science *a la mode geometrique*. This is precisely the rationalistic and aprioristic method of Descartes.

The rationalistic and aprioristic nature of Walras's "rational method" help to account, I believe, for the difficulty of testing general equilibrium models[14]. Walras never intended to test his theory of general economic equilibrium. "The return to reality" does not occur in order to test the theory, but "only with a view to practical applications." Moreover, the relations depicted are not the ones existing in fact. They show us only how in an "ideal market we have ideal prices which stand in an exact relation to an ideal demand and supply."

The third point of interest to us is the role of the assumption of perfect competition. Pure economics for Walras meant the pure theory of value in exchange, and this, in turn, meant an equilibrium theory of price determination under perfect competition. Any discussion of disequilibrium falls, by necessity, outside the province of pure economics. Walras's decision to construct price theory as a branch of Cartesian physics forced him into this position.

"In science," Walras averred, "our domain is that of ideas, of the ideal, of perfection." [Jaffé, 1983, p. 345 n.6] Perfect competition is the essential assumption of general equilibrium theory. Walras had construed value as a property inhering in things and the theory of value as a branch of physics. But there was a open door through which the free and cognitive human will might enter — trading at false prices. To close this door, Walras assumed perfect competition. Walras compared the assumption of perfect competition with the assumption in "pure mechanics" that "machines are perfectly frictionless." [Walras, 1954, p. 84] But there is a difference. In pure mechanics, the assumption of frictionless machines is a simplifying assumption which may be disposed of when it becomes convenient to do so. In the "pure theory of economics" the assumption of perfect competition is alpha and omega. As soon as the assumption is relaxed, things that are useful and limited in quantity cease to be exchangeable against each other in determinate ratios; exchange values come to depend on the unique sequence of transactions, expectations, the distribution of knowledge, and all manner of accidental human phenomena. Under these conditions, value in exchange ceases to be purely the result of the exercise of the blind and ineluctable forces of nature and becomes, in part, the result of the exercise of the free and cognitive human will. In this case, the theory of value both loses its ideal character and ceases to be a natural science. Thus it was necessary for Walras to assume perfect competition and to include in that concept a tatonnement process under which all trading is suspended until the equilibrium price vector has been hammered out. If price theory is a branch of Cartesian physics, then price theory must be equilibrium theory.

6. Conclusion

Walras's Cartesian ontology led him to construct a mechanistic price theory and to consider his theory a branch of Cartesian physics. His Cartesian epistemology led him to construct an equilibrium theory which is difficult to test empirically. (It was meant to be "applied" not tested.) May we draw any inferences for present-day economic theory? There are, perhaps, many lessons to be learned from a study of the foundations of Walras's economics. I will suggest only one, that general equilibrium theory is not itself a theory of the invisible-hand.

A theory of the invisible hand would have to explain how, when certain social institutions are present, individual actions lead to regular social structures whose creation or perpetuation formed no part of the intention of any of the individuals whose chosen behaviors nevertheless generated them. Clearly, a theory from which individual action has been excised, a theory intended to contribute to Cartesian physics, cannot itself be a theory of the invisible hand. General-equilibrium theory is not, as Frank Hahn once said, a "pure theory of the

invisible hand (Hahn , 1982)."

If Walras's model somehow embodies insights or truths about the social order induced by market institutions, then there would seem to be some need to explain how such a "bloodless" or "mechanistic" order could emerge from human action. Such an explanation cannot be expected from general-equilibrium theory itself. Such an explanation would involve both "subjectivist," "hermeneutical," or "interpretive" elements and "mechanistic" elements.[15] Only a combination of "interpretive" and "mechanistic" explanatory principles can explain how "Nations stumble upon establishments, which are indeed the result of human action, but not the execution of any human design (Ferguson, 1767, p. 187 as cited in Hayek 1967, p. 96)."

Notes

1. The demand that only that which is certain be accepted as true is the essence of the Cartesian program. For Walras, see [1954, p. 15, 70, 71, 181, 256, 427-8, and 471]. See also, [Jaffé, 1983, p. 10, 127 and p. 127 n. 15].
2. Not all justifications demand certainty. Fallibalism and justificationism can be perfectly compatible.
3. These propositions assert things like "what I perceive clearly and distinctly is true" and "the ego is thinking stuff." They are not really self-justifying since one discovers them to be true when attempting to doubt all things. It is this mode of discovery which justifies them.
4. For Walras's use of geometry as a model of scientific knowledge, see [Walras, 1954, pp. 52-3, 71-2 and 471].
5. Walras then mentions a book, *Philosophie de la Science*, on which he had been working for two years. If Walras had been working on the book for two years, and if Jaffé did not err in assigning the letter to the spring of 1859, then Walras had been actively pursuing the philosophy of science before he devoted himself to economics. The book was never published. See, [Blaug, 1980, pp. 40-1].
6. The highly developed character of Walras' thought at this point, while impressive in any event, it not an entirely Jovian feat of intellectual creation. In his social ideas, his philosophy, and even to a degree in his technical economics, Leon Walras owed much to his father. See [Jaffé, 1983, pp. 1-52].
7. Whether the goodness of a perfect God is a sufficient condition for the veracity of the geometric method, I leave to the reader's judgement.
8. These reason are the presuppositions of the logic which led Descartes to assert the certain existence of a perfect God who could not be a deceiver. Being logically prior, they are, in a way, more fundamental.
9. See *Principles* part 1 article 45 [5, 20] for explications of "clear " and " distinct".
10. Compare Walras, [1954, p.62].
11. In the *Etudes d'économie sociale* Walras's argument is slightly different. There is also discusses the fine arts whose criterion is the beautiful.
12. By "all of us taken collectively," Walras seems to intend the state. See *Etudes d'economie sociale* pp. 90-1, where Walras refers to the state as society conceived in abstraction from the individual.
13. In reality, Descartes argued, God created the world "right from the start with all the perfection it now has." [Descartes, 1984a, p. 256]
14. See Hands 1985.
15. For an extended discussion of what such an explanation would look like see Koppl nd.

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