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Abstract of the doctoral thesis: The role of Money in Linear Production Systems*

by
Constantinos Gogolos

This paper shows that within the framework of analysing neoricardian theory, i.e. in linear production systems, money neither exists nor can it be introduced. First of all, it should be stressed that neoricardian theory investigates prices that are exclusively determined by the technical conditions of production of the economy, based on the hypothesis that there is a uniform rate of profit, a uniform nominal wage rate and a uniform price in the economy for each produced commodity. Technical conditions of production are expressed on the basis of an aggregate of separate concepts. Some of these are the following: the concept of *production process*, the concept of *production system* and the concept of *production technique*. A production process is an expression that represents not only the inputs necessary for the production of a certain quantity of a specific commodity, either single or joint, but also the produced commodity itself. If the produced commodity is single, the production process is known as a single production process, while if it is joint, it is known as a joint production process. It should be noted here that production expressed by a production process is characterised by the

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The Seven-Member Examination Committee was made up of the three members of the Advisory Committee and
Associate Professor Stella Karagianni (University of Macedonia)
Professor Ioannis Vavouras (Panteion University)
Professor Theofanis Benos (University of Piraeus) and
Professor George Hatziconstantinou (University of Thrace).

element of linearity, thus, for example, if the inputs of a specific production system are doubled, its outputs will also be doubled. A production system is a representation, which expresses a specific aggregate of production processes, which is placed on a specific activity level. A production technique is an aggregate of infinite production systems, in which however the production systems use the same production processes.

According to neoricardian theory, the economy at a given moment in time uses a specific production system. If, now, the production system used by the economy is a single production system, i.e. it uses only processes of single production, and it produces n commodities, then the (absolute) prices of this production system emerge from a system of n equations with n+2 unknowns, where the unknowns are the prices of the commodities, the uniform nominal wage rate and the uniform rate of profit. The aggregate of these equations for a given nominal wage rate does not determine any price magnitude, either absolute or relative. It simply tells us that the prices of the commodities are polynomial functions of the rate of profit, which in order to be determined necessitate determination of the rate of profit. When the rate of profit is given, the aforesaid system of equations, which relates to the determination of prices, becomes a linear system of equations, which determines only the relative prices of commodities – and not always these. In order to determine absolute nominal magnitudes, a further equation, known as the *normalisation equation*, is introduced to the system of equations of prices for the given production system. By means of this equation, we set the price of a commodity or a bundle of commodities, which is known as the normalisation commodity, equal to a positive constant. If the said constant has dimension, then prices are expressed in terms of this dimension; if it does not have dimension, then prices are expressed in terms of the normalisation commodity. For a given normalisation equation and a given level of rate of profit, the system of prices determines the absolute prices of the commodities. When, for a given normalisation equation, the nominal wage rate is given, although we are again in a position to determine absolute price magnitudes, these are as a rule not uniquely determined.

In the paper, I show that it is impossible for the normalisation equation to introduce real money because, in the general case, any change in the normalisation equation brings a change in a) the relative prices and the

maximum economically significant rate of profit of the production systems under investigation and b) the classification and the selection of the dominant technique when, as the criterion for the classification and selection of the technique, both the criterion of the w-r-relationship, i.e. the relationship between the nominal wage rate and the rate of profit, and the criterion of cost minimisation are used. It should be noted that the w-r-relationship criterion is one that is used to investigate the profitability of techniques, while that of cost minimisation is a criterion applied to investigate the cost of techniques. The aforesaid changes however, which come about as a consequence of a change in the normalisation equation, are contrary to what happens in real economies. In real economies at each moment in time, the prices of commodities are uniquely determined in real money terms, and therefore uniquely determined magnitudes are not only the relative prices of commodities, but also the classification and selection of the dominant technique within the framework of an aggregate of techniques on the basis of their profitability and their cost – since they are calculated on the basis of already uniquely determined prices in money terms.

However, I do not restrict myself only to these findings. Going further, I explain that the nominal magnitudes determined for a given normalisation equation within the framework of a given production system are not characteristic magnitudes of the given production system, but characteristic magnitudes of the *normalisation subsystem* corresponding to it, which pertain also to magnitudes of the given system. A normalisation subsystem is that production system, which uses the technique of the given production system, but which produces the normalisation commodity as its net product.

This becomes immediately clear within the framework of a given system of single production, which is characterised by the following two elements: a) it produces only one basic commodity and only one non-basic commodity which enters its own production, and b) the maximum rate of profit of the production process of the basic commodity is greater than that of the production process of the non-basic commodity. Here, I set the maximum rate of profit of the production process of the basic commodity as the rate of profit ascertained therein, when the basic commodity gets strictly positive prices and the nominal wage rate is zero. I set the maximum rate of profit of the production process of the non-basic commodity as the rate of profit that

emerges in this process, when the non-basic commodity gets strictly positive prices and the basic commodity and nominal wage rate zero prices. It should also be noted here that a commodity is basic when it enters the production of all the commodities of a given system, while it is non-basic in the following two cases: a) in the case where it does not enter into the production of any commodity of the given system and b) in the case where it enters into the production of only certain commodities of the system. When, within the framework of the system being examined, we use a unit of the basic commodity as the normalisation commodity, then for each rate of profit, the nominal wage rate and consequently also the w-r-relationship, i.e. the relationship between the nominal wage rate and the rate of profit, results exclusively from the conditions of production of the basic commodity and the normalisation equation. However, because of the requirement introduced to the said models, according to which, in a given production system, the nominal wage rate, the rate of profit and the prices of commodities are single magnitudes in each production process, the w-r-relationship resulting from the process of production of the basic commodity pertains also to a w-r-relationship of the given system being examined. *Thus, we see that the aforesaid resulting w-r-relationship is not a characteristic magnitude of the given system, but of a subsystem of that system which uses the processes with which the normalisation commodity is produced and leads prices and the w-r-relationship to such levels that the price of the normalisation commodity is equal to that defined by the normalisation equation.* The maximum economically significant rate of profit of this w-r-relationship is the maximum rate of profit of the process of production of the basic commodity. For all other higher rates of profit, both negative nominal wage rates and negative levels of prices emerge for the non-basic commodity. The fact, however, that the aforesaid w-r-relationship is not a characteristic magnitude of the given production system has certain important consequences for the price of the non-basic commodity. For certain rates of profit of this economically significant w-r-relationship, the process of production of the non-basic commodity leads the non-basic commodity to undetermined and negative prices. However, because in the real economy there can be no conception of a produced commodity with an undetermined or negative price, it follows that the said negative and undetermined prices are those *mathematical conditions*, which

must be satisfied so that certain levels of the rate of profit, which are attained in the process of production of the basic commodity, are attained also in the process of production of the non-basic commodity – even though in an analogous real economy, the process of production of the non-basic commodity will not be able to attain such levels for the rate of profit. At this point, it should be noted that when the rate of profit tends to the maximum rate of profit of the process that produces the non-basic commodity, the price of the non-basic commodity tends to plus-minus infinity. If, however, a bundle of commodities is used as the normalisation commodity, which (bundle) consists not only of the basic but also the non-basic commodity and the rate of profit tends to the maximum rate of profit of the process that produces the non-basic commodity, then the price of the non-basic commodity becomes positive. Furthermore, for this second normalisation commodity, the w-r-relationship is determined not only by the production process that produces the basic commodity, but also by the production process that produces the non-basic commodity. The maximum economically significant rate of profit in this case becomes equal to that of the process of production of the non-basic commodity. For all other higher rates of profit, the w-r-relationship becomes a one-to-one relationship, which entails also negative nominal wage rates. Lastly, the economically significant w-r-relationship that emerges from this new normalisation commodity pertains also, by virtue of the requirement of uniformity of price magnitudes, to a w-r-relationship of the given system.

It should be pointed out here that in each case, irrespective of the form of the technique used by the production system being investigated, neither the position nor the slope of the graphical representation of the w-r-relationship is determined by characteristic magnitudes of the given system, but by characteristic magnitudes of the normalisation subsystem corresponding to it. Thus, it emerges from the above that both the w-r-relationships as well as the relative and absolute prices corresponding to them are not characteristic magnitudes of the given production system, but characteristic magnitudes of the normalisation subsystems corresponding to it.

This finding constitutes the basis for the interpretation of another finding deduced in this paper, namely that any change in the normalisation commodity brings a change also in the classification and selection of the

dominant technique. The usual capitalist criteria for selecting a technique are the criterion of the w-r-relationship and the criterion of cost minimisation.

With the criterion of the w-r-relationship, we either classify techniques according to the nominal wage rate, to which they lead for a given rate of profit and given normalisation equation, and we subsequently select the one that leads to the highest nominal wage rate, or we classify them according to the rate of profit, to which they lead for a given nominal wage rate and given normalisation equation, and we subsequently select the one that leads to the highest rate of profit. In this second form, it is quite clear that that the said criterion is a profitability criterion. However, we have already explained that the w-r-relationship that emerges within the framework of a given system, and consequently also within the framework of a given technique, is nothing more than a characteristic magnitude of the normalisation subsystem corresponding to it. So, the said criterion is not a criterion for classifying an entire set of techniques on the basis of their profitability and the selection of the most profitable, but a criterion for classifying, on the basis of their profitability, the normalisation systems that correspond to the said techniques for a given normalisation commodity, and the selection of the most profitable one.

The same holds for the criterion of cost minimisation. First of all, it should be pointed out that with this criterion, we investigate techniques that differ with respect to one and the same production process and we select as the dominant technique the one that minimises the cost of the differing process, where the cost of the differing process includes also the profits that result in it for a given rate of profit. It should also be noted here that the cost of the differing process of one of the given techniques being examined, is calculated not only on the basis of the prices of that technique, part of which is the said process, but also on the basis of the prices of the other techniques being examined. However, because a) this cost relates to the cost of production of an aggregate of production processes, which produce the same commodity and b) a normalisation equation is presupposed, it follows that eventually the said criterion is not a criterion for comparing techniques, but a criterion that investigates that aggregate of production systems, which use the said techniques and, as net product, they produce both the normalisation commodity and one unit of the commodity of the differing process. It is

however very likely that while certain normalisation commodities lead to normalisation subsystems that contain the differing process, certain others will not contain it. In the first case, the cost of the differing process is determined by magnitudes in price terms, in the determination of which the differing process itself participates, while in the second case, its cost is determined by nominal magnitudes that have emerged irrespective of this and which may have no economic content. In the paper, I provide an example in which, when the normalisation subsystem does not contain the differing process, the criterion of cost minimisation sets as the dominant technique a technique that always uses more means of production than the other techniques being examined. Clearly, such a selection of technique is devoid of economic content. In order to attain results with economic content, we must use normalisation commodities that lead to normalisation subsystems that include also the differing process. In this case moreover, the investigation of the technique that minimises cost is equivalent to the investigation of that normalisation subsystem which entails the lowest prices. Thus, it becomes quite apparent that the criterion of cost minimisation, when it leads to results with economic content, is a criterion for selecting normalisation subsystems, since with this criterion the normalisation subsystem that minimises prices is selected.

Concluding the paper, I make a critical analysis of Bidard's "market algorithm" and Neumann's "general equilibrium model". I do so because both Bidard's "market algorithm" and Neumann's "general equilibrium model" are considered to be models for the unambiguous selection of technique. In the aforesaid analysis, I show that the said models do not lead to the unambiguous selection of technique, but to the unambiguous selection of certain production systems, the prices of which may be random. More specifically, Bidard's model concerns classification with respect to the level of the real wage rate of an aggregate of production systems, which produce real wage rates of common composition and in which the surplus product has the same composition as its means of production. At the same time, it uses the real wage rate as normalisation commodity, and therefore the said classification and selection constitute classification and selection of normalisation subsystems. Neumann's model concerns the classification and selection of production systems, in which the surplus product has the same

composition as the aggregate of means of production and real wages. This classification and selection is performed on the basis of the level of the surplus product in question, in relation to the means of production and real wages, to which each of the systems in question leads. It should be noted here that in this model, no normalisation equation is introduced; if one were introduced, then the results would change in correlation with the normalisation commodity.

This paper thus establishes that the neoricardian theory cannot suitably express what is actually happening in the real economy, since it is not in a position to introduce real money to its models, at least with respect to its accounting function.