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Some Reflexions on Classical Equilibrium, Expectations and Random Disturbances

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1. INTRODUCTION

The usual argument in favour of the notion of equilibrium applied to the classical theory of prices is preanalytical and runs as follows. *i*) In the presence of all sorts of accidental factors which affect individual behaviour, economic analysis cannot theorize the exact levels of market prices, but only average levels. *ii*) In the real world, we do not observe arbitrary differences between the market price and the cost of production of a certain commodity or among the rates of reward of the same mean of production employed in different industries. *iii*) Competition is the force which in the short run sets a constraint on these differences and — in the absence of further disturbances — would lead to their disappearance in the long run, if its equalizing effect is not impeded by coalitions or by specific institutional factors. With regard to this general view, various analytical arguments have been presented in order to validate or to reject the classical notions of "natural", or "normal" or "production" prices, as centres of gravitation of market prices. According to a certain interpretation of Adam Smith's point of effectual demand, it should be possible to theorize the sign of the change in market prices and to show the convergence of these prices to their natural values, associated with a long period state of the economy, although the precise path of the adjustment process cannot be explained or predicted (Garegnani 1983).

A widespread objection against this view warns us that, in order to legitimize a theory based on long period states, it is not enough to explain the direction of the change toward these states. A comparative statics proof of stability is only a conjecture of dynamic stability. The supporters of this objection advocate a formal theory of disequilibrium processes in order to prove that the long period state is stable in some relevant sense. A similar

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view is held not only by those who oppose the revival of classical economics (for reasons mainly related to the theory and not to the method implemented), but also by some economists who want to build a more solid basis for the theory of production prices. Both parties pursue some sort of disequilibrium dynamics, usually formalized as a system of difference or differential equations. Then the test of the legitimacy of long period states would become very demanding: the test must ascertain whether stability exists, whether it is not too local, whether the attractor is independent of the adjustment path and whether the convergence process is quick enough. From this perspective a proof of asymptotic stability is not a sufficient test of gravitation.

However, if we accept the challenge of the formal disequilibrium test suggested by this line of criticism, we must face a dilemma. If we admit that the disequilibrium model also contains some error of specification, then this model is also unable to explain the market prices exactly. A serious cumulation of errors over a sequence of rounds or iterations might make the test not reliable. In turn it would be required to prove by means of a disequilibrium model of higher order that the path determined by the former disequilibrium model is some sort of stable moving equilibrium. By contrast, if we believe that the model describes with precision the dynamics of the system and it "proves" that gravitation of market prices toward production prices exists and has the properties required, the method of long period states would become legitimate, but, at the same time, useless. In fact, should this stage be achieved, we would resort directly to the "perfect" disequilibrium model and the method of approximation based on attractors should be dismissed as a non necessary approximation. I do not deny that formal disequilibrium analysis may offer interesting insights and explain some possible sources of instability. However, anyone who has followed this route knows quite well how sensitive the stability properties of disequilibrium models are in respect to small changes in the parameters within plausible ranges of variation. The disequilibrium approach certainly serves to check whether *specific* disequilibrium models possess an attractor or not, but it seems to be unable either to disprove or to prove *in general* the gravitation of market prices towards production prices and therefore the validity of the method of long period states applied to the theory of value and distribution.

It can be noticed here that the problem of gravitation of market prices to production prices is sometimes formulated by the supporters of disequilibrium models like a stability analysis of neoclassical equilibrium carried out in real time. I will argue below that the differences in the two rival theories of prices require also a different approach to the analyses of convergence and to the kind of empirical correlates on which each theory of prices must be founded. The following topics will be examined with regard to this issue: the notion of attractor, the theory of expectations, the role of random disturbances and the empirical correlates of long period states.

2. TWO DIFFERENT NOTIONS OF ATTRACTORS

In classical economics the notion of equilibrium is borrowed from classical mechanics. We usually resort to the analogy of the movement of a pendulum suspended in a turbulent environment where random currents of air or water affect it erratically. Instead of this narrow mechanical analogy, some broader concept of attractor has been proposed occasionally. On the basis of biological analogies, Marshall (1920) and Pigou (1935) suggested the notion of a state which is stationary at macro-level although consistent with non-stationary positions of the single agents; an important insight already emphasized by P. Newman (1960). Furthermore D. G. Champernowne (1937, 1953), P. Newman — J.N. Wolfe (1961) and J. Steindl (1962) developed the concept of stochastic equilibrium related to random walks. More recently a similar notion of equilibrium — albeit different in important features — has been tentatively explored in economics (see E. Farjoun and M. Machover (1983)) on the basis of the concept of equilibrium adopted in statistical mechanics in general and, in particular, associated with the probabilistic notion of entropy developed by Boltzmann (1872). There is a common idea underlying all these different notions of attractor: a long period state can be described by some stationary characteristics at macro-level, as a result of non stationary characteristics at micro-level which exhibit recurrent compensating deviations from their norms. According to the probabilistic notion of attractor, a long period state of the economy is conceived as a *statistical concept* related to a population of agents: a frequency distribution with maximum probability, in which some relevant characteristics of the population remain constant, but in which the exact state of each agent cannot be predicted. Then, the task of explaining the disequilibrium path of individual prices and quantities is outside the reach of our theoretical field. Following this approach, the assumption of a uniform rate of profit on the supply price of capital goods can be interpreted as an aggregate condition which is compatible with a long run distribution of reshuffling firms and processes in terms of different rates of return on capital employed.

The concept of equilibrium described above is well known and it is often advocated in economics as a useful substitute for the concept of equilibrium adopted from the classical mechanics. However, actual economic theorizing often does not follow the methodological recommendations and in the usual practice we still resort to the old concept of equilibrium borrowed from classical mechanics. (Marshall was a typical representative of this double attitude). I believe that the revival of the classical approach and the recent debate on gravitation can benefit from an explicit adoption of this statistical concept of equilibrium, especially if attention is addressed to the empirical test of the classical theory. A preliminary step to be made, in order to pursue

this aim, is an explicit recognition of the role of expectations and of random disturbances in the theory of prices, still maintaining the traditional notion of long period states.

3. ON EXPECTATIONS: A. SMITH AND J. MUTH

With regard to expectations I will argue that important theoretical differences and important methodological similarities exist between the *old* classical economics, whose recent revival has been prompted by the contribution of Piero Sraffa (1960), and the *new* classical economics that ensued from the seminal article of John Muth (1960). As is often the case in economics, the roots of both approaches can be traced back to Adam Smith.

Let us formulate e simple gravitation model on the basis of the adjustment mechanism proposed by Smith and supplemented by a *weak* version of the rational expectations hypothesis developed by Muth. We read in the *Wealth of Nations*:

> "The actual price at which any commodity is commonly sold is called its market price. It may either be above, or below or exactly the same with its natural price. The market price of every particular commodity is regulated by the proportion between the quantity which is actually brought to market, and the demand of those who are willing to pay the natural price of the commodity, or the whole value of the rent, labour and profit, which must be paid in order to bring it thither. (Wealth of Nations Ch. VII p. 56).
>
> "If at any time [the quantity brought to market] exceeds the effectual demand, some of the component parts of its price must be paid below their natural rate... If it is wages or profit, the interest of the labourers in the one case, and of their employers, in the other, will prompt them to withdraw a part of their labour or stock from this employment. The quantity brought to market will soon be no more than sufficient to supply the effectual demand". (ibidem, p. 57).

Consider now the model which Muth used in order to introduce his innovative hypothesis. In his words:

> "We can best explain what the hypothesis is all about by starting the analysis in a rather simple setting: short-period price deviations in an isolated market with a fixed production lag of a commodity which cannot be stored". (Muth 1960, p. 317).

Let us here replace the functional relations between the deviations of the market values from the equilibrium values, which appear in Muth's model, by relations between the *signs* of the deviations. We shall use the terms "normal price" and "normal quantity" in order to encompass both the notion of equilibrium in the "new" classical economics and that of long period states in the "old" classical approach.

Let $\overline{P}$ be the normal price, $\overline{Q}$ the normal output, P_t the market price and Q_t the output brought to the market at time t.

Price adjustment

In the passage quoted from Smith, the market price of the product seems to be regulated by the rule:

(1a) $$P_t \gtreqless \overline{P} \quad \text{if} \quad Q_t \gtreqless \overline{Q}.$$

However, a more general adjustment mechanism has also been described by Smith. In his words (WN p. 116):

> "In the linen or woollen manifactures, for example, the same number of hands will annually work up very nearly the same quantity of linen and woollen cloth. The variations in the market price of such commodities, therefore, can rise only from some accidental variation in the demand. A public mourning raises the price of black cloth".

Therefore random shocks may affect the demand side. This possibility can be taken into account in the theory of gravitation by replacing (1a) with

(1b) $$P_t \gtreqless \overline{P} + \mu_t \quad \text{if} \quad Q_t \gtreqless \overline{Q}.$$

where μ_t is a random variable. Hence at a certain time t the excess price $(P_t - \overline{P})$ and the excess quantity $(Q_t - \overline{Q})$ may have the same sign, because the latter excess may be more than compensated by a level of demand which is accidentally higher than the norm $\overline{Q}$.

Quantity adjustment

Different specifications of the quantity adjustment are consistent with the passage quoted from Smith. According to a plausible interpretation, a state in which the market price would be above (or below) the normal price would, if it were to be persistent, induce an increase (or a decrease) in the amount of the commodity brought to the market and would lead eventually to a deviation of the same sign between the actual level and the normal level of output. Evidently Smith's argument by-passes the role of expectations and the existence of lags. Let us consider these elements explicitly and assume that the deviation of the actual output at time t from its norm is determined by the plans of production chosen at time $t-1$ and by a random variable which represents, for example, the effects of the erratic weather conditions. Suppose that this deviation is positively related (although not *functionally related*) to the deviation of the expected price from the normal price. The relevant expected price is the price which, on the average, the producers expect to rule at time t on the basis of their information at time $t-1$, that is $P^e_t \equiv E(P_t|I_{t-1})$. Then the quantity adjustment relation is

(2a) $$Q_t \gtreqless \overline{Q} + \epsilon_t \quad \text{if} \quad P^e_t \gtreqless \overline{P}$$

where ϵ_t is a random variable.

Let us re-write (1b) and (2a) in terms of sign relations:

(1) $$\text{sign } (p_t - \mu_t) = -\text{ sign } q_t$$

(2) $$\text{sign } (q_t - \epsilon_t) = \text{sign } p^e{}_t$$

where $p_t = P_t - \overline{P}$ is the deviation of the market price, $p^e{}_t = P^e{}_t - \overline{P}$ the deviation of the expected price and $q_t = Q_t - \overline{Q}$ the deviation of the actual output.

Assume that ϵ_t and μ_t have zero mean and are normally distributed and serially uncorrelated. As $E\epsilon_t = 0$ and $E\mu_t = 0$, we obtain from (1) and (2)

(3) $$\text{sign } p^e{}_t = -\text{ sign } Ep_t$$

Rational expectations

Let $\hat{P}_t$ be the price which at time t the average producer believes to be the normal price and let $\hat{p}^e{}_t = P^e{}_t - \hat{P}_t$ be the corresponding expected deviation. Assume that expectations are rational in a *weak* sense: if the model predicts a market price above (below) the objective normal price $\overline{P}$, the producers on the average expect a market price above (below) their subjective normal price $\hat{P}_t$ and also above (below) the objective normal price $\overline{P}$. Hence the following double equality is imposed:

(4) $$\text{sign } \hat{p}^e{}_t = \text{sign } p^e{}_t = \text{sign } Ep_t$$

Clearly, equation (3) and the second equation (4) are incompatible. The only rational price expectation consistent with the prediction of the model is:

(5) $$\hat{p}^e{}_t = p^e{}_t = 0.$$

It follows that:

(6) $$Eq_t = 0 \text{ that is } \mathrm{EQ_t} = \overline{\mathrm{Q}}$$

(7) $$Ep_t = 0 \text{ that is } EP_t = \overline{P}.$$

Hence the expected quantity and the expected price deduced from the theory are the normal quantity and the normal price respectively; the same result as obtained by Muth.

4. THE CLASSICAL APPROACH REINTERPRETED

Let us summarize the general features of the gravitation model (1)-(7).

a) It is assumed that the producers on the average do not make systematic errors in the prediction of the *sign* of the deviation of market prices from the normal price.

b) It is *not assumed* that the expectations of the price *level* are rational. In fact the model does *not assume* $P^e{}_t = EP_t$.

c) The underlying theory of normal magnitudes ($\overline{P}$, $\overline{Q}$), may be substantially different from the Walrasian framework in which the rational

expectation hypothesis has usually been embedded, insofar as $\overline{P}$ can be conceived as a production price and $\overline{Q}$ as a normal quantity determined determined by the effectual demand and consistent with non-natural unemployment.

Remarks *a*), *b*) suggest that the amount of knowledge and the capability of processing information which the average producer is supposed to possess are much lower in the old classical approach followed above, compared with the assumption usually made by the new classical economists. It is well known that, according to the latter, the condition $P^e_t = EP_t$ should be interpreted as the result of a learning process that is not instantaneous in principle. The point at issue is whether the speed of convergence of the individual "theories" is comparable with the speed of convergence of prices and quantities towards their long run state. Of course, the plausibility of the convergence hypothesis extended to individual expectations depends on the content of the "expectandum". The rational expectation hypothesis cannot be judged plausible or implausible independently of the complexity of the model in which it is adopted. The sign relations (1)-(2) can be taken as common knowledge on the side of competitive producers. By contrast, a quite different burden is placed on individual rationality, if we assume that the individuals tend to predict *as if* they knew the structure — at least locally — of a complex model (maintaining the usual qualifications such as "on the average" or "apart from non-systematic errors" and so on). Even the simple 2-parameter model used by Muth in the introductory section of his article requires a questionable learning capability and his assumption can be defended only by resorting to the comparative predictive power of the model tested.

Our reformulation of Muth's model serves to show that it is possible to lower the complexity of his introductory model, in terms of the informational requirements attributed to the observed agents, down to a certain minimum level, without decreasing the explanatory power of the theory itself. If such a reduction is possible, it seems wise to pursue it. In more general models — in which the analysis of an isolated market is abandoned and replaced by a multisectoral analysis — such a reduction might be unfeasible and a methodological question must be faced: whether to calibrate the complexity of the model — hence its explanatory and predictive scope — in which the rational expectation hypothesis is implemented, according to the presumed degree of informational capability of the agents observed, or to assume that expectations are rational only relatively to a subset of predictions deduced from the model.[1]

[1] With regard to a system of interrelated markets this second choice does not necessarily require that expectations should be assumed rational only in respect to the variables of the subsystem which are supposed to be of direct concern to the agent himself: *e.g.* the market in which he operates.

5. THE EMPIRICAL CORRELATES OF THE NORMAL STATE

In the classical debate on gravitation it is not usual to move the discussion on the ground of a statistical test. Most believe that the level of abstraction of the theory of production prices, formulated under the assumption of a uniform rate of profit, is not apt to justify its direct assessment on the basis of empirical evidence. I agree with this view, but at the same time I am convinced that facing the problem of how the theory of production prices can be tested *in principle*, may help to clarify an important problem of interpretation which still surrounds the classical approach in its development from A. Smith to P. Sraffa: the role of the random disturbances.

Let us interpret the normal price and the normal quantity in equations (6), (7) as the point of effectual demand in Adam Smith's sense. The model discussed so far predicts that market prices and quantities gravitate towards the point of effectual demand $(\overline{P}, \overline{Q})$, although it does not itself explain this point. An empirical test of the model consists in plotting the observed market prices against the observed quantities and then assessing the dispersion of the observed points in respect to their barycenter; the latter being of course calculated by taking frequencies like masses. Under these circumstances, we expect to find the scatter diagram represented in Fig. 1.

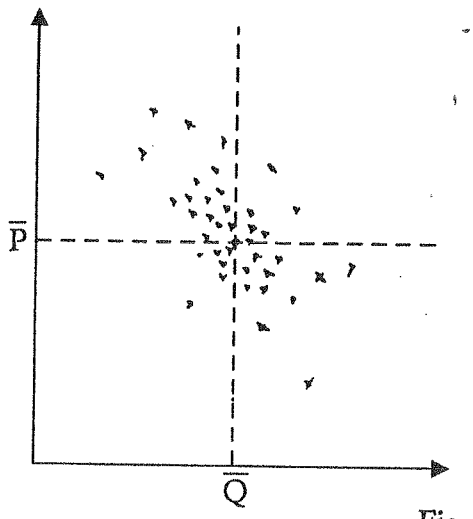

Fig. 1

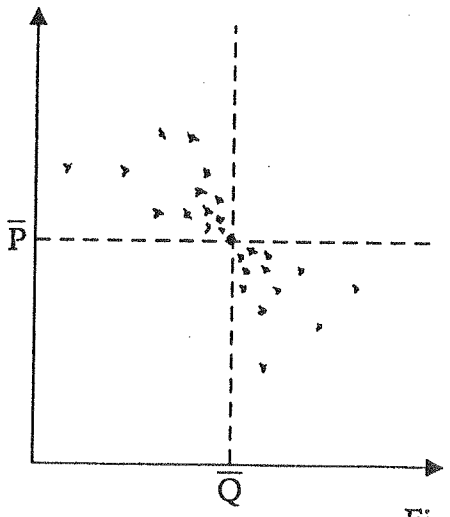

Fig. 2

The model can be simplified by assuming that the accidental events do not affect the demand for the commodity, but they intervene only on the production side. In this case the sign-relation (1) is reduced to (1a) and the point of effectual demand can be described by a scatter diagram (Fig.

2) where the points predicted by the model fall only in the North-West and in the South-East quadrants defined in respect to the barycenter.[2]

An important difference appears in respect to a typical test of a price theory based on supply and demand. In the statistical exercises described in Fig. 1 and in Fig. 2, no estimate of structural coefficients and no problem of identification are involved, because no functional relation has been assumed. In each exercise only one point had to be "estimated": the point of effectual demand. Within these limits, the theory is apt to explain correlations between prices and quantities *ex post*.

6. SOME AFTERTHOUGHTS

The influence of random disturbances on the fundamentals

In the previous sections, the accidental factors have been assumed in order to explain the deviations of the actual states from the normal state of the economy. This role assigned to random disturbances is typical of a theory of price gravitation. However, the same perturbations may play an important role also with regard to the so-called "fundamentals" of the normal states. In fact, as has already been suggested (Parrinello 1989), some persistent characteristics of the accidental perturbations may affect the choice of the methods of production in use and therefore they belong to the (indirect) determinants of the production prices.

In the model (1)-(7), a certain random sequence of bad and good weather can be assessed as normal, apart from periodic seasonal changes. Therefore the choice of the cheapest method of production, including the choice of a certain amount of inventiores, may depend *also* on some statistical characteristics of these perturbations. For instance, in agricolture the choice of the method of cultivation may change without any variation in the *average* output $\overline{Q}$, if the *variance* of the output changes. As a consequence, the quantities of commodities and labour in the equations of production prices, as in Sraffa's price equation $\mathbf{Bp} = (1 + r)\mathbf{Ap} + w\mathbf{l}$, must not necessarily be interpreted as a result of a cost minimizing choice along a steady growth path associated with perfect foresight. In fact, the empirical correlates of these quantities are time averages representeing the methods of production *in use*, which are supposed to be the result of choices that take into account those persistent characteristics of the distribution of random events.

If we accept this interpretation, the problem of gravitation must be analyzed in respect to those *abnormal* accidental factors which induce a

[2] The representation in Fig. 1 shares the interpretation of the point of effectual demand suggested to me orally by A. RONCAGLIA. Instead the representation in Fig. 2 was proposed by Garegnani (1983).

revision in the process of formation of average expectations; the normal accidental factors being already embedded in the long run state and not being the cause of changes in the average state of expectations.

On competition and selection

In this final section a conjecture is presented in favour of the relative robustness of the gravitation process of market prices towards production prices in the face of changes in the behavioural hypotheses, compared to the robustness of the stability of equilibrium prices determined by supply and demand.

The "as-if" principle and the "selection" argument invoked by Friedman (1953) and Alchian (1950) as a line of defence of the neoclassical assumption of optimizing behaviour, exhibit a special weakness if they are extended to a general equilibrium theory. The gap considered here adds to the criticisms raised by Sidney Winter (1964) against the same argument. The question is: how can the selection argument be extended from the theory of the firm to the theory of the consumer? Hirschleifer in his *Economics from a biological viewpoint* (1977) argues that "preferences are governed by the all-encompassing *drive for reproductive survival*". (Hirschleifer p. 19). His position states that preferences emerge endogenously through a selection mechanism. However, *even if* his contention is accepted, we still face another issue: why utility maximization — or, more generally, why behaviour explained by the choice of *one preferred* alternative — should be a condition for survival of consumers (endowed with such endogeneous preferences), in the same sense as profit maximization is supposed to be a condition for survival of the firms?

Let us reformulate a famous passage of M. Friedman by substituting the "utility maximizer consumers" for the "profit maximizer firms". The quotation (Friedman, op. cit. p. 22), after such an arbitrary substitution acquires the following puzzling content:

> "... whenever habitual reaction, random chance, or whatnot happens to lead to behaviour consistent with rational and informed maximization of utility, the individual will prosper and acquire resources with which to expand; whenever it does not, the individual will tend to lose resources and can be kept in existence only by addition of resources from outside".

The assumptions of optimizing behaviour on the side of the firms and on the side of the consumers play a symmetrical role within a general equilibrium theory of prices under perfect competition. Therefore the neoclassical theory of prices based on supply and demand seems to be less sheltered by the selection argument in respect to a theory where the attractors are inherently linked to competitive and selective processes on the side of producers. We may conjecture that the regularities which would allow us to explain the gravitation of market prices towards production prices are more robust than

the regularities underlying the stability of equilibrium prices in the rival theory, because they seem to be less sensitive to the choice of specific assumptions concerning the rationality of consumers' behaviour outside equilibrium.

On the relativity of the method of long period states

The method of long period states in economics has been applied to the theory of prices under the proviso of analytical separability between this theory and the theory of the composition of output. It is qustionable whether the method itself can be extended to other realms of economic enquiry, like the theory of the composition of consumption, where the forces of competition cannot play the same selective role in order to explain individual behaviour. This doubt about such an extension suggests a certain relativity in the implementation of the method according to the role attributed to the force of competition and selection. However, a second kind of relative fitness of the method is sometimes advocated.

According to one view, the validity of the method should be assessed relatively to the historical circumstances of the economy analyzed. It is maintained that the method is apt to analyze an economy in which the technical conditions of production are relatively stationary or slowly changing, but that it would hardly be useful in an historical era, like the present one, in which innovative activity is so pervasive. It is not easy to measure the relative pace of the present flow of innovations in respect to the technical changes which took place during Adam Smith's and Ricardo's time and to adopt it as a criterion for assessing the method at issue. Suppose, for the sake of the argument that the process of technical change which affects the modern industrialized countries today is faster in some meaningful sense, compared with that experienced by the Classics and suppose that production prices are changing more rapidly now due to the quick changes in the methods of production. We still find that the relativistic argument mentioned above is not conclusive. In fact, the flow of innovations which affects the adjustment in economic variables (in particular the innovations in information technology and in plant flexibility) can also be faster, so that the assumption of gravitation of market prices toward rapidly changing production prices might be maintained and be not less plausible than before.

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