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Expectations in a Steady-State Model of Capacity Utilization

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This paper was inspired by Committeri's interesting "comments on recent contributions on capital accumulation, income distribution and capacity utilization",[1] and in particular, on the steady state model which he refers to as the Rowthorn and Amadeo model.[2] In what follws I shall discuss the points raised by Committeri which I consider central to his analysis, namely, the (in)adequacy of steady-state models for the determination of long-period capacity utilization, and the role of expectations in long-period models. In the second section of the paper a steady-state anlysis of capacity utilization which explicitly considers the role of long-period expectations, will be discussed.

1. ON STEADY-STATE MODELS

The first central point raised in Committeri's comments refers to the identification of steady-state models with long-period analysis, and in

* I should like to thank Amitava Dutt and Lance Taylor for past discussions on issue related to those treated in this paper, and to Jose Marcio Camargo for discussions during the preparation of this paper.

[1] M. COMMITTERI, "Some Comments on Recent Contributions on Capital Accumulation, Income Distribution and Capacity Utilization", *Political Economy*, vol. 2, n. 2, 1986.

[2] A few words on the development of steady-state capacity-utilization models. The paper by Bob Rowthorn, "Demand, Real Wages and Economic Growth", first appeared in 1981 (*Thames Papers in Political Economy*), and was reproduced in 1982 (in *Studi Economici*, n. 18). A similar model (applied to an open economy) can be found in Lance Taylor's book *Structuralist Macroeconomics* (New York, Basic Books) published in 1983. Lance Taylor personally told me that the model in his book was written after he saw the first draft of what was to become Amitava Dutt's "Stagnation, income distribution and monopoly power", *Cambridge Journal of Economics*, 1984. Dutt was Taylor's student at MIT. My purpose in E. J. AMADEO, "Notes on Capacity Utilization, Distribution and Accumulation" (*Contributions to Political Economy*, vol. 5, 1986) was to compare the steady state capacity utilization models with the traditional Keynesian and Marxian models, to consider explicitly the introduction of planned or normal capacity utilization in the desired accumulation function (or investment function), and discuss the implications of the model for the relation between distribution and accumulation.

particular, the adequacy of these models for the study of the determination of long-period capacity utilization. He argues as follows:

> In the approach of both authors [Rowthorn and Amadeo], "long-period analysis" is predominantly based on steady states, also called "equilibrium positions" of the economy. The identification of long-period analysis with steady state appears to be unduly restrictive, given the highly artificial features of steady states.[3]

There are at least two different dimensions in the notion of steady states which should be considered here. The first (and more general) one refers to an equilibrium position characterized by the configuration of the endogenous variables associated with a given set of exogenous variables (data), and the parameters specifying the technological, behavioural and expectational functional relations of the model. In equilibrium, producers, and for that matter, all the other relevant agents in the economy, must "be content with what they are doing",[4] the conditions specifying the technology must prevail, and expectations must be satisfied.[5]

The second dimension of the notion of steady state is associated with a configuration of the relevant variables of the analysis towards which the system converges or around which it gravitates. The process of adjustment is emphasized in this dimension. This particular characterization of steady states requires two conditions to be satisfied. First, the stability conditions associated with the adjustment process of the system (including those associated with the expectational functions) must be satisfied. The second condition refers to the role of expectations. These are affected by two sets of factors. Past and current events naturally affect expectations: agents take these events as an approximation for what is to come in the future. Expectations, whem formed in this way, are not always fulfilled during the adjustment process, and this is why they influence the path of the system (although not the equilibrium position). The other set of factors is composed of new information, the institutional setting in which decisions are taken, and the psychology of decision makers. In steady-state models, only the first set of factors are allowed to change over the adjustment process. The determinants of the second set of factors are assumed to be frozen during this process, and, therefore, are part of the data.[6] It can reasonably

[3] Cf. M. COMMITTERI, *op. cit.*, p. 169. For a list of "artificial features" of steady states according to Committeri, see note 12 of his comments.

[4] R. HARROD. *Towards a Dynamic Economics*, London, Macmillan, p. 81; quoted by Committeri, p. 12.

[5] For a detailed discussion of the notion of equilibrium and its relation to the neo-Ricardian notion of long-period position or centre of gravitation, see E. J. AMEDEO and A. DUTT, "The Neo-Ricardian Keynesians and the Post-Keynesians", *Discussion Paper* n. 153, Departamento de Economia, PUC-RJ.

[6] For an example of the role of expectations applied to Keynes's multiplier adjustment mechanism, see E. J. AMADEO, *Keynes's Principle of Effective Demand and Its Relationship to Alternative Theories of Distribution and Accumulation*, unpublished Ph.D dissertation, Harvard University, 1986.

be argued that these two conditions are too restrictive. However, it will have to be admitted that they are imposed on the system with the objective of studying the path and the tendentional values of the endogenous variables of the system associated with the data. Once they are determined, the elements of the data can be altered, and the effect of these changes on the equilibrium position can be analysed.

The notion of steady states (or equilibrium position) is simply an organizing concept which provides "an organized and orderly method of thinking out particular problems".[7] In this sense it plays the same role as the Classical notion of centres of gravitation. According to the latter, "long-period positions are significant as centres of gravitation of prices and quantities produced, and as such they need never coincide with actual situations".[8] Furthermore, according to this notion, "there is ... room for the fluctuations in quantities and prices and disappointment of expectations that occur in reality".[9] It should be noted — and, indeed, the model developed in the second section of the paper will try to argue in this direction — that these characteristics of centres of gravitation are not inconsistent with the notion of steady states.

In comparing the notions of centers of gravitation and steady states, there are two aspects which should be considered. In the first place, why are the assumptions surrounding the notion of steady states more restrictive than those associated with the notion of centres of gravitation? In particular, what makes the gravitational movement of the system around the long-period position stable? Or, what are the specific conditions which prevent the Classical mechanism of competition from being explosive? The second point is related to the first, but it refers particularly to the role of expectations. The question is: how are the entrepreneurs', or producers', expectations assumed to be formed? Is it through an expectation function, or is it through an assumed stable trial-and-error process?[10] These are questions which are usually faced in steady-state models, and should be faced in centres of gravitation models as well.

The differences between models based on the notions of steady state and centres of gravitation are not all that great. The former can be seen as a particular case of the latter in which the functional relations of the system (including expectational relations) are explicitly specified. This particular characteristic of steady-state models allows them to yield definite

[7] Cf. J. M. KEYNES, *The General Theory of Employment, Interest, and Money*, London, Macmillan, 1936, p. 297.

[8] R. CICCONE, "Accumulation and Capacity Utilization: Some Critical Considerations on Joan Robinson's Theory of Distribution", *Political Economy*, vol. 2, n. 1, 1986, p. 21.

[9] *Ibid.*, p. 23.

[10] Take the Classical example of the gravitation of market prices around natural prices due to differences between the expected domand (which determines supply) and effectual demand. What garantees that the way expectations are formed will make the market prices gravitate around the natural prices?

configurations of the dependent variables associated with a given set of data variables. The results of centres-of-gravitation models may be more general; but they tend to be less conclusive.[11]

2. ON THE ROLE OF LONG-PERIOD EXPECTATIONS IN CAPACITY-UTILIZATION MODELS

The second point raised by Committeri refers to the role of expectations in capacity-utilization models. His position is summarized in the following passage:

> In both versions of the model (Rowthorn's and Amadeo's), there is the possibility of utilization being *different* from its normal degree, even in states of equilibrium... This result appears to be in contrast with the features traditionally attributed to steady states, where normal utilization degree is assumed to prevail... and to be *maintained* over time ... owing to the assumption of self-sustained fulfilment of expectations... The *systematic* under- or over-utilization of productive capacity that characterizes Rowthorn's and Amadeo's steady states leads us to ask what kind of expectations are implicit in their investment functions, and whether their fulfilment can be made consistent with situations of systematic non-normal utilization of capacity.[12]

Committeri's comments raise very important questions. First, what kind of expectations are implicit in the investment functions of the steady-state capacity utilization models? Second, if the long-period expectations are fulfilled in equilibrium, is it still the case that the equilibrium (realized) degree of utilization and the normal degree will not necessarily coincide? Raising these two questions is one of the great merits of Commiteri's (and also Ciccone's) analyses. Indeed, the role of expectations was not considered in the original steady-state capacity-utilization models. In the model discussed in the second section of the paper these points will have to be taken into account.

Before turning to the model, however, there is a conceptual point which must be discussed. It refers to the notions of "normal", "planned", "expected" and "realized" degrees of capacity utilization. In my 1986 article the notions of normal and planned degrees have a very similar meaning, that is, the degree of utilization which firms fix as a target degree. Usually the normal degree will be smaller than one, so that firms will always be able to respond to unexpected changes in the demand for their products. According to this meaning of the term, the normal degree, once decided upon, never changes. In my 1987 article, both terms are still used more

[11] See my comments on Ciccone's analysis in E. J. AMADEO "The Role of Capacity Utilization in Long-Period Analysis", *Political Economy*, vol. 2, n. 2, 1986.

[12] M. COMMITTERI, *op. cit.*, p. 170.

or less interchangeably but I there give them a slightly different connotation. This still refers to the normal degree in the sense that firms chose it as a precautionary measure against unexpected changes in demand. But it also had the meaning of an expected (and in this sense the term "planned" is much better than "normal") degree of utilization.[13] In my interpretation, both Ciccone and Committeri use the terms "normal" and "expected" to mean the "expected degree".

In what follows the terms "normal" and "expected" degrees will have different meanings. The normal degree will be associated with firms precautionary measure against demand shocks. It will be determined by the past experience of the firms. The variance of demand in the past can be thought of as a central determinant of the normal degree. Here, the normal degree will be taken as *given*, and indeed, assumed to be independent from the determinants of the expected degree of utilization. If the expected degree of utilization is greater than the precautionary or normal degree it is only reasonable for firms to invest more. Otherwise, given the variance of demand, they will eventually face situations in which the flow of output associated with full utilization of capacity (or potential output) will fall short of demand. The fact that firms expect a higher or lower degree of utilization in the future, as compared with the precautionary degree, does not affect the latter, it only affects the firms desired rate of growth of the stock of capital.

The realized (or equilibrium) degree of utilization is the outcome of the interaction of the decisions to save and invest in the economy. According to the model discussed in section 3, the (average) expected degree of utilization and the (average) realized degree are both endogenously determined and, in equilibrium, will be equal to each other. But they will be equal to the normal or precautionary degree only by a fluke. If one allows the independent determinants of the expected degree of utilization to change, this will generate a gravitational movement of the expected and realized degrees around the long-period average degree of capacity utilization. Finally, it will be argued that in the case in which long-period expectations are fulfilled, the negative correlation between the share of wages in output and the rate of profit does not necessarily hold.

3. A MODIFIED STEADY-STATE MODEL OF CAPACITY UTILIZATION

As noted above, given the distinction between the normal (in the precautionary sense of the term) and expected degrees of utilization, desired investment (as a ratio of the capital stock) may be thougth of as a positive

[13] It is precisely for this reason that I explore the nature of the equilibrium position in my "The Role of Capacity Utilization...", *op. cit.*, p. 155.

function of the difference between the latter and the former. Put in a linear form, the desired accumulation function can be written as follows:

1) $$h^i = \alpha + \beta(u^e - u^n)$$

where u^e and u^n stand for expected and normal degrees of utilization, respectively. The saving:capital ratio is given by:

2) $$h^s = \gamma u$$

where

3) $$\gamma = 1 - (w/\pi)\ (c_w - c_k) - c_k,$$

where w is the real wage, π is the productivity of labour, u is the actual or realized degree of capacity utilization, and c_w and c_k are the propensities to consume out of wages and profits, respectively.

Let us assume an initial situation in which the expected and normal degrees are equal. The realized equilibrium degree of utilization (u^*) is given by $u^* = \alpha/\gamma$. Depending on the values of α and γ, the equilibrium degree will be smaller than, equal to or greater than the expected (and in the present case) normal degrees. In figure 1 a situation is depicted in which the equilibrium degree is smaller than the expected degree.

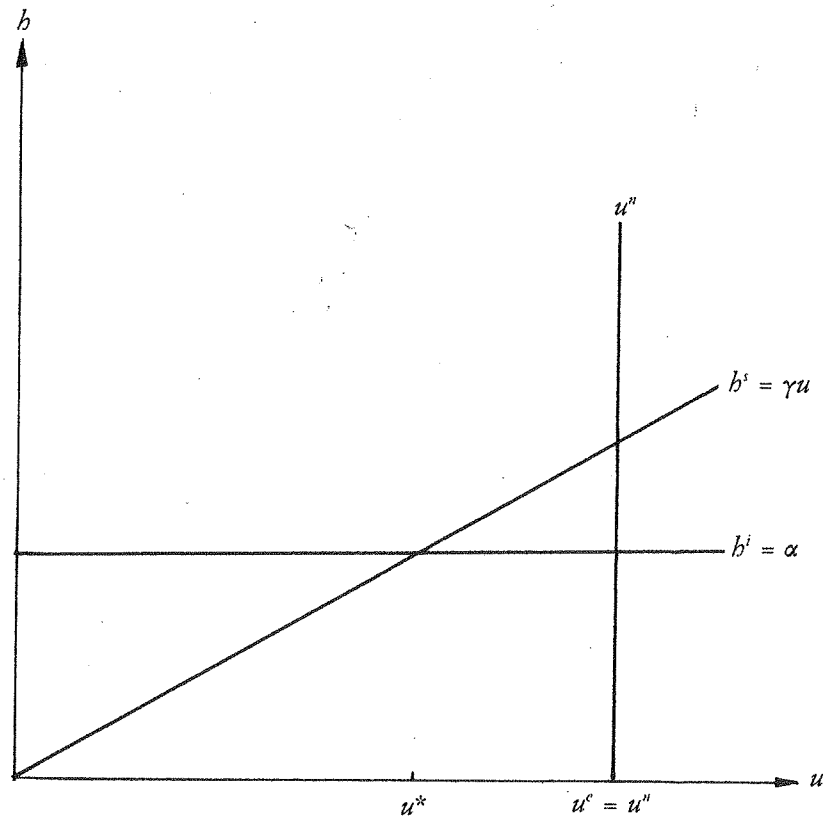

Figure 1

In figure 2 different equilibrium degrees are associated with different values of γ, for a given value of α. As γ decreases the slope of the saving function becomes smaller, and the equilibrium degree associated with the intersection of the saving and desired accumulation functions becomes greater.

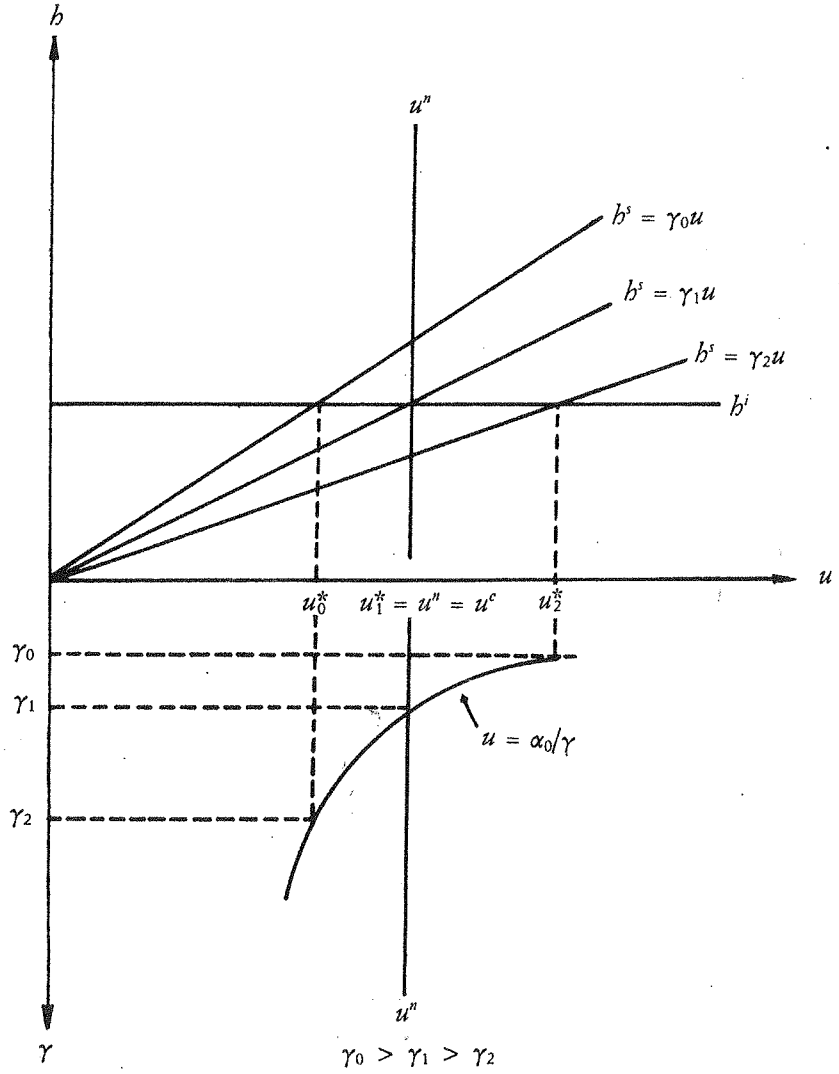

Figure 2

Equilibrium positions (or pseudo-equilibrium positions) in which the equilibrium degree differs from the expected degree correspond to the equilibrium positions characteristic of the original steady-state capacity-

utilization models. Let us refer to them as "first-stage equilibrium positions", meaning by this temporary equilibrium positions. Equilibrium positions in the present model correspond to situations in which the equilibrium degree is equal to the expected degree; otherwise expectations would not be fulfilled. Let us suppose that the economy is in situation characterized by a first-stage equilibrium in which the equilibrium degree is different from the expected degree. If this is a persistent situation, entrepreneurs will eventually revise their expectations. The expected degree of utilization can be thought of as being affected by two types of factors. First, the current degree of utilization, which in our case is given by the first stage equilibrium degree. Second, by independent elements such as new information and a new institutional atmosphere not captured by the past degree of utilization. In oder to formalize the effect of these two factors, we can assume that the expected degree of utilization in period t is given by the following expectation function:

$$4) \qquad u_t^e = u_{t-1}^e + \lambda (u_{t-1}^* - u_{t-1}^e) + e_t$$

where λ measures the speed of adjustment of u_t^e in relation to differences between the last period's realized and expected degrees of utilization, and e_t represents the independent determinants of the expected degree in period t. We assume that e_t is a random variable with a mathematical expectation equal to 0, that is $E[e_t] = 0$. On average therefore e_t equals zero. We shall associate the average situation (characterized by $e = 0$) with the long-period (average) position (LPAP) of the system. The latter can be thought as an analog of the Classical long-period or centre of gravitation position.

3. THE LONG-PERIOD AVERAGE POSITION (LPAP)

In general, if the system is not in the LPAP, and the expected and normal degrees of utilization are not equal one to the other, the first-stage equilibrium degree of utilization will be given by

$$5) \qquad u_t^* = [\alpha + \beta (u_t^e - u^n)]/\gamma$$

In order to determine the second-stage equilibrium or LPAP degree of utilization, we substitute u_{t-1}^* as determined by equation 5 for u_{t-1}^* in equation 4. Recalling that in equilibrium $u^* = u^e$ the solution to equation 4 will be given by:

$$6) \qquad \bar{u}^e = \bar{u}^* = [\alpha - \beta u^n]/[\gamma - \beta]$$

where $\bar{u}^e = \bar{u}^*$ is the second-stage equilibrium or LPAP degree of capacity utilization. The stability condition for the adjustment processes of u^e and u^* is given by $\gamma > \beta$, which means that the speed of adjustment of the

desired rate of accumulation to changes in the differences between the expected and the natural degrees must be smaller than the sensitivity of the saving function with respect to changes in the realized degree of utilization. We now have an equilibrium position in which expectations are fulfilled. Both the realized and expected degrees of utilization are endogenously determined, and they will equal the normal degree only by coincidence. In the short period, during the adjustment process to changes in the parameters or data variables, the realized and expected degrees will normally differ from one another.

The adjustment process of the system which would correspond to the (disequilibrium) position depicted in figure 1 is depicted in figure 3. In period zero the expected and normal degrees coincide, and the realized (first-stage equilibrium) degree of utilization is smaller than the expected degree. According to equation 4 the expected degree in period 1 would fall. In fact, it would be given by:

$$u_1^e = u_0^e + \lambda[(\alpha/\gamma) - u_0^e] = u_0^e - \lambda[u^n - (\alpha/\gamma)] < u^n$$

where α/γ is the value of u^* in period zero.

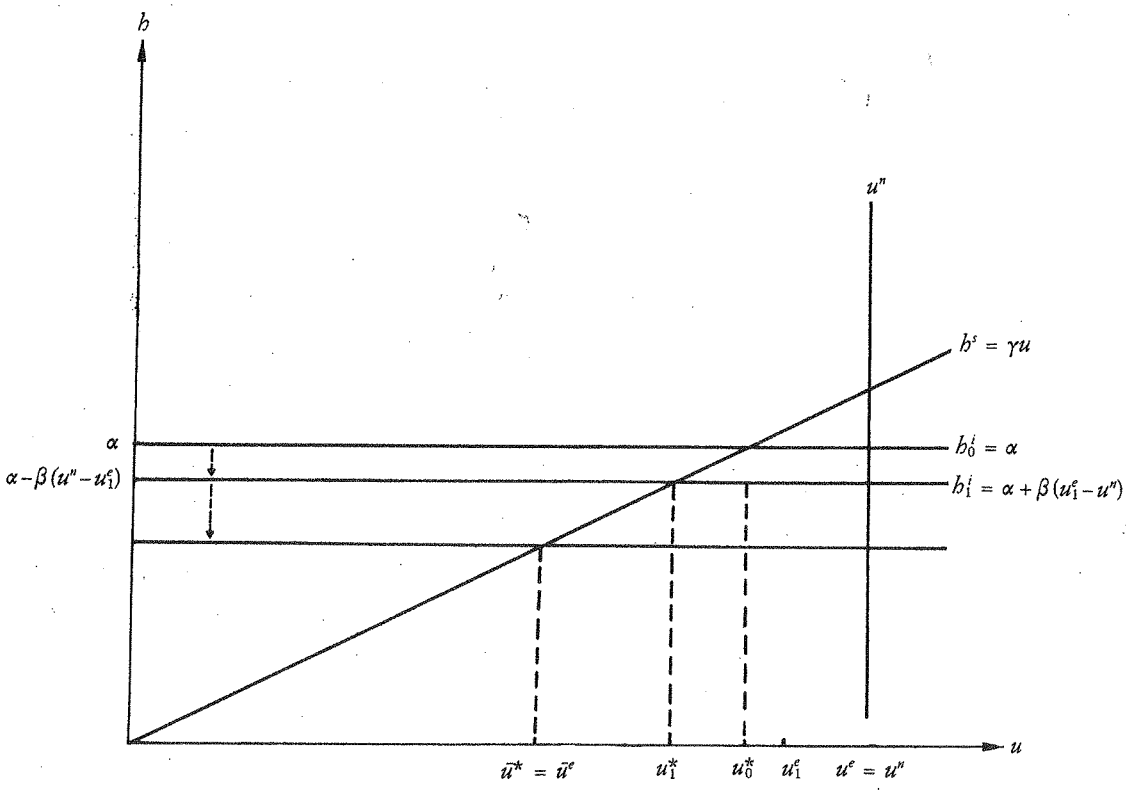

Figure 3

Both the desired rate of accumulation and the realized degree of utilization in period 1 will be affected by the difference between the expected and normal degrees of utilization. They will assume the following values respectively:

$$h_1^i = \alpha - \beta(u^n - u_1^e)$$

and

$$u_1^* = [\alpha - \beta(u^n - u_1^e)]/\gamma < u_0^*$$

The adjustment process will continue up to the point in which the expected and realized degrees of utilization are equal to the value given by equation 6.

4. CHANGES IN LONG-PERIOD AVERAGE POSITIONS

We may now study the effect of changes in the parameters or data variables. These changes will affect the LPAP degree of utilization, rate of accumulation and rate of profit. As an example, we may study the effect of a reduction in the share of profits in output, which will reduce the parameter γ. In fact, if we make the Kaleckian assumption that capitalists do not consume and workers do not save, the parameter γ becomes the share of profits in income. The effect on the LPAP degree of utilization is given by:

$$(\delta\bar{u}^e/\delta\gamma) = (\delta\bar{u}^*/\delta\gamma) = -[\alpha - \beta u^n]/[\gamma - \beta]^2 < 0$$

Therefore the effect of a reduction in the share of profits on the degrees of utilization is positive. The effect on the rate of accumulation will also be positive. If we make the Kaleckian assumptions referred to above, the rate of profit is equal to the rate of accumulation, and, therefore, the effect on the rate of profit will be positive as well. The effect of this parametric change in distribution on the rate of profit, the rate of accumulation and the degree of utilization is represented in figure 4.

The reduction in the share of profits is represented in the figure by the increase in the share of wages in output $(1 - \gamma)$. The change in γ will shift the relevant distribution curve through the effect on capacity utilization. In quadrant I of figure 4 the change will be represented by a movement from point A to point B, which corresponds to an increase in the rate of profit (from $\bar{r}_0$ to $\bar{r}_1$) and in the rate of accumulation (from $\bar{h}_0$ to $\bar{h}_1$). According to this exercise, even in the case of a steady-state model in which expectations are explicitly taken into account, if the usual Kaleckian assumptions are made and capacity utilization is not fixed *ex-hypothesis*, there is a positive relation between the real wage and the LPAP rate of profit. The major result of the original steady-state models of capacity utilization concerning the distribution of income is therefore robust to the introduction of long-period expectations in the analysis.

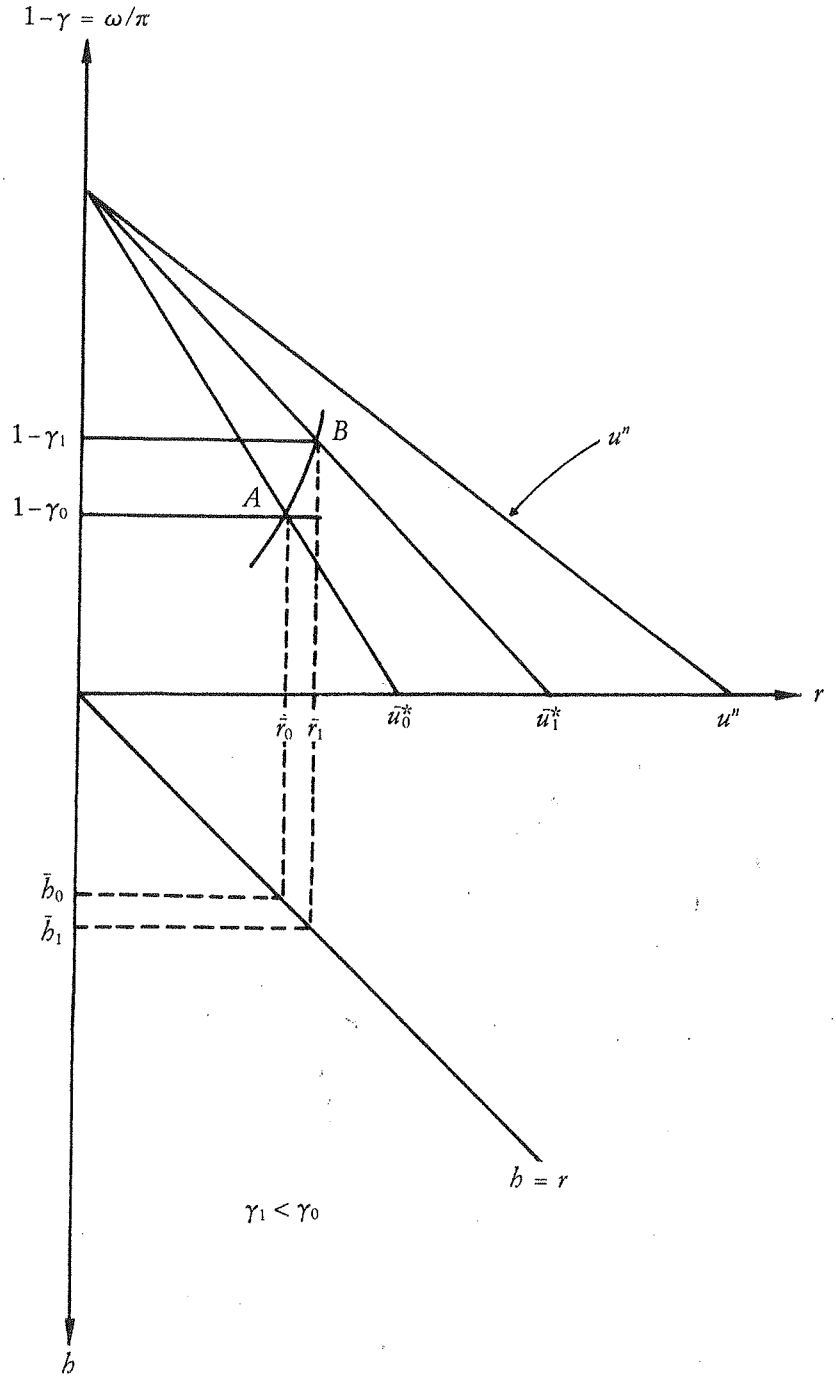

Figure 4

The effect of a reduction in the share of profits can also be seen in figure 5. In the figure, the degree of capacity utilization is measured in the vertical axis, and "time" is measured in the horizontal axis. The normal degree is assumed to be given and smaller than one.

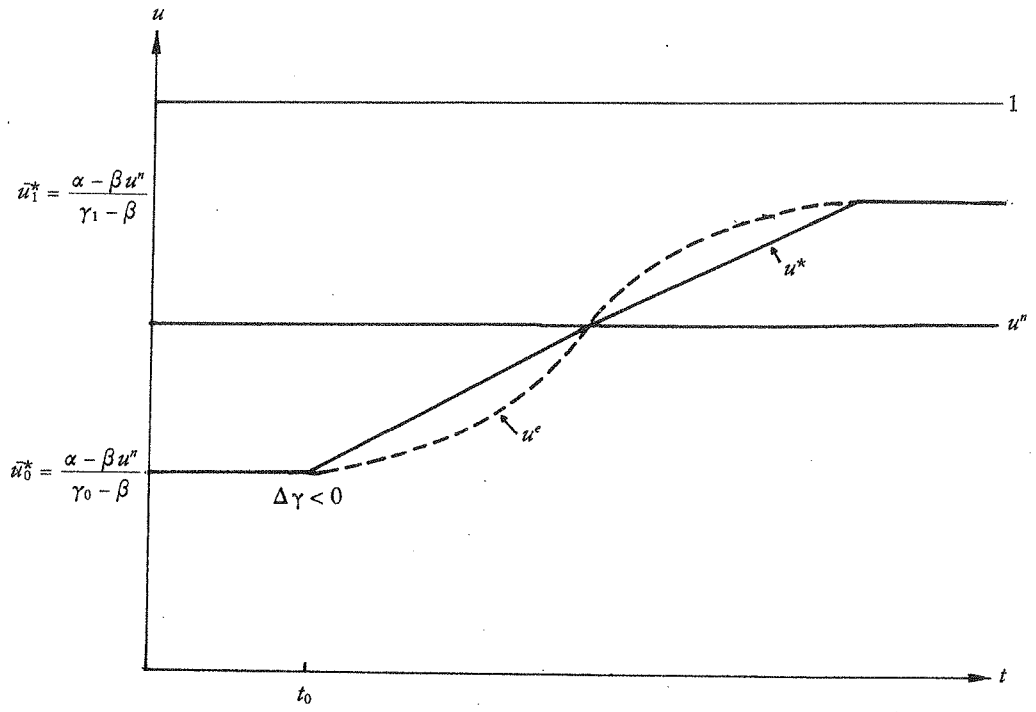

Figure 5

Given the change in the distribution of income, first the realized and then the expected degrees of utilization will start to increase. The path of adjustment may not be smooth as depicted in the figure; but the path of the two degrees will certainly not coincide. The two degrees will only be systematically equal in the new LPAP. Note that in the example depicted in the figure the LPAP degree was smaller than the normal degree before the change in distribution, and greater after the change. Therefore, changes in the parameters or data variables may explain differences between the realized degree of utilization and the normal degree.

5. GRAVITATION AROUND THE LPAP

We may finally take stochastic changes into account, that is, the effect of random changes in the independent determinants of the expected degree of capacity utilization. These changes are associated with (temporary) changes in the value of the random variable e. This variable may take either positive or negative values. Let us suppose that e assumes a given value, say $\tilde{e}$, which does not change for a period "long" enough for the system to converge to a position of rest. Equation 4 would then be written:

$$u_t^e = u_{t-1}^e + \lambda (u_{t-1}^* - u_{t-1}^e) + \tilde{e}$$

The realized degree of utilization associated with this position of rest ($\tilde{u}^*$) would not correspond to its expected analog ($\tilde{u}^e$). In fact, in this hypotheti-

cal position of rest the difference between the two degrees of utilization would be given by:

7) $$\tilde{u}^* = \tilde{u}^e - \tilde{e}/\lambda$$

Note that $\tilde{u}^*$ would be smaller than $\tilde{u}^e$ if $\tilde{e}$ was positive and viceversa. From equation 5 we know that whenever u^* differs from u^e, u^* will be given by

5) $$u^* = [\alpha + \beta(u^e - u^n)]/\gamma$$

Equations 5 and 7 together yield the value of u^e associated with the case in which e takes a value different from zero "on average":[14]

8) $$\tilde{u}^e = [\gamma/(\gamma - \beta)]\ \{[(\alpha - \beta u^n)/\gamma] + [\tilde{e}/\lambda]\}$$

Note that for $e = 0$, equation 8 yields the same result as equation 6. In figure 6 a situation is depicted in which the expected and realized degrees of utilization converge to a position of rest (different from the LPAP in which $\bar{u}^* = \bar{u}^e$) associated with a given value of $e = \tilde{e}$ greater than zero.

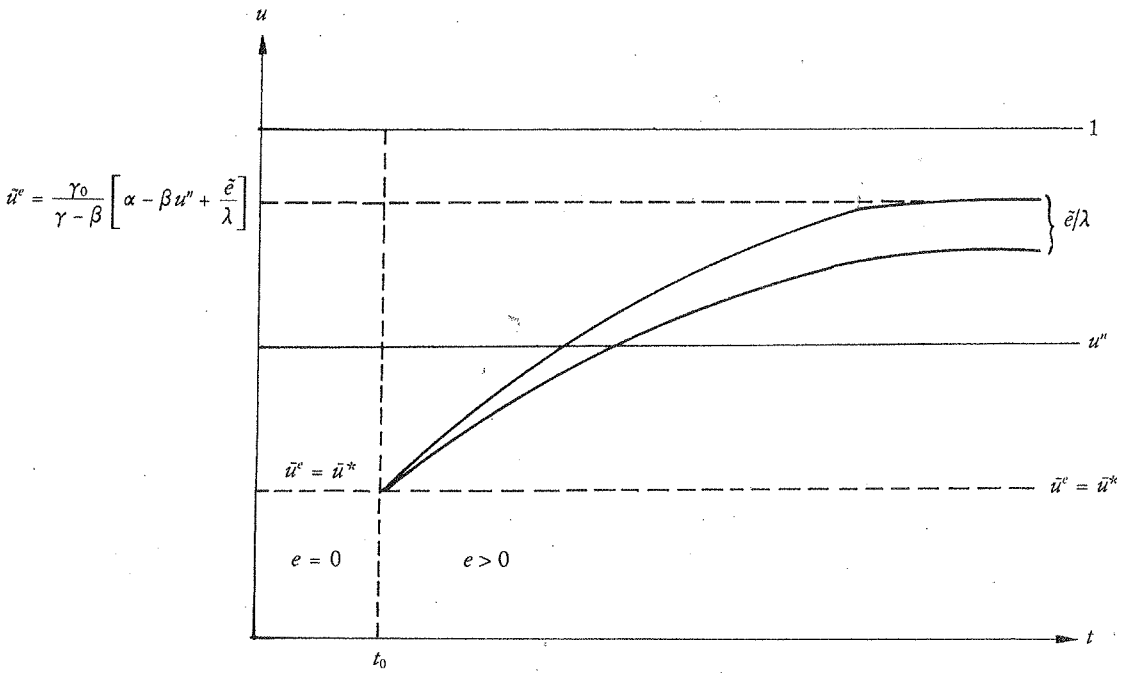

Figure 6

[14] Does it make any sense to have e assuming any given value for a period "long" enough for the system to converge to a position of rest? It makes analytical sense. It allows us to calculate the tendential values of u^* and $\tilde{u}^e$ associated with the assumed value of e. For each new value of e we can calculate the tendential values of $\tilde{u}^*$ and $\tilde{u}^e$, and, therefore, trace the path of these variables over "time" and around the LPAP characterized by an average value of e equal to zero, and equality between the average expected and realized degrees of utilization.

We may finally consider the effect of recurrent changes in the value of the independent determinant of the expected degree of utilization, namely, recurrent changes in e. To each new value of e, there corresponds a position of rest in wich the expected and realized degrees of utilization are different from each other. In figure 7 these values are $\tilde{e}_1 > 0$, $\tilde{e}_2 < 0$, $\tilde{e}_3 > 0$.

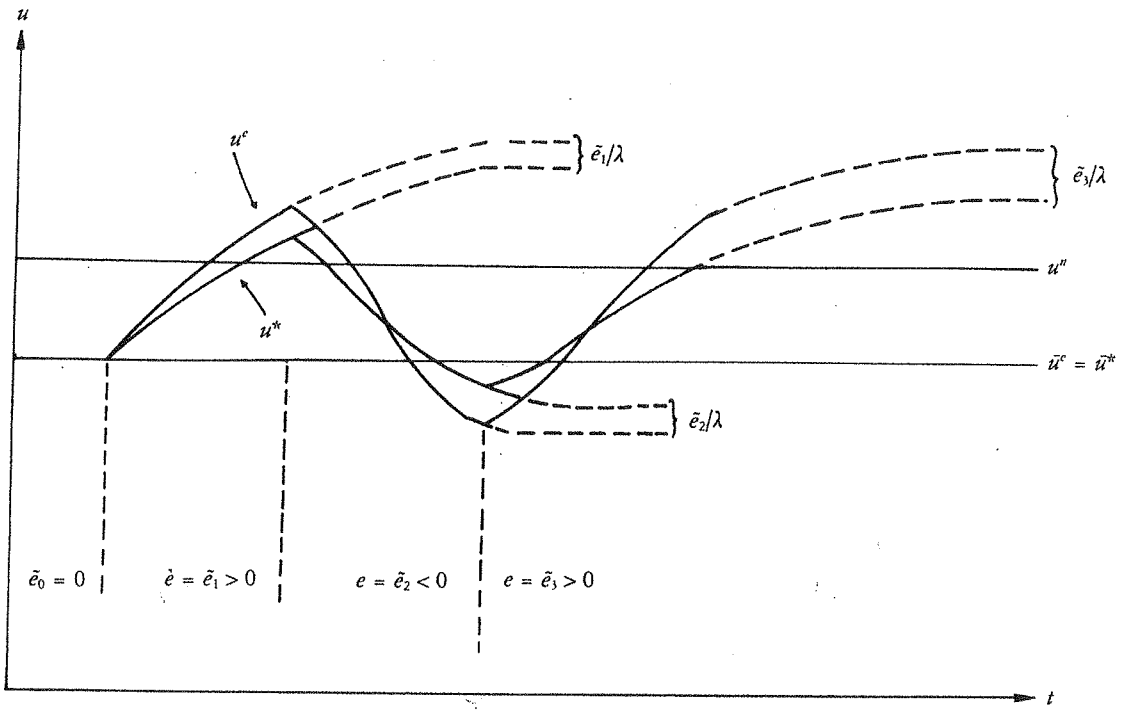

Figure 7

The conclusions which may be derived from this exercise are the following. If e changes recurrently — as we have reason to believe it actually does — in general, the realized, expected and normal degrees of utilization will not be equal to each other. The realized and expected degrees will be equal on average (since the average value of e is zero). However, the normal and LPAP degree of utilization will not be equal, even on average. That is, they may be equal, but only by a fluke.

6. CONCLUDING NOTES

We have discussed a steady-state model of capacity utilization and distribution in which expectations are explicitly considered. In the model, the long-period position is characterized by an average situation in which

the effect of changes in the exogenous determinants of expectations on the degree of utilization, and the rates of profit and growth, are cancelled out. The long-period average configuration of the dependent variables depends on the values assumed by the data variables and the parameters specifying the functional relations of the system. If any of these values change, the equilibrium position will change accordingly. In short-period or disequilibrium positions, expectations are not always fulfilled, and, in general, the expected and realized degrees of utilization will differ. In LPAP, the expected and realized degrees will be equal to each other, but they will not necessarily be equal to the normal degree of utilization. It was also shown that under specific conditions the Classical inverse relation between the wage and the rate of profit does not necessarily hold.

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