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Capacity Utilization, Distribution and Accumulation: a Rejoinder to Amadeo

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In his new paper,[1] Amedeo discusses some of the points raised in my comments to his previous contribution.[2] In particular, the author presents a modified version of his "steady-state model of capacity utilization", in which firms fix a "target" degree of capacity utilization, to be achieved through their investment decisions, on the basis of the relevant expected events. Amadeo's intent is to show that while investors' expectations are validated by current experience in steady-state equilibrium, realized and normal degress of utilization may diverge persistently.

As Amadeo seems to argue, such a steady-state solution would obtain if some rule of expectations formation (lacking in the earlier version of the model) were introduced.[3] In short, the new model consists of four equations:

(1)	$h_t^i = a + b(u_t^e - u^n)$	[investment function]
(2)	$u_t^e = u_{t-1}^e + v(u_{t-1} - u_{t-1}^e) + e_t$	[adjustment rule for expectations][4]
(3)	$h_t^s = c\ u_t$	[saving function]
(4)	$h_t^i = h_t^s$	[equilibrium condition]

[1] E. J. AMADEO, "Expectations in a Steady-State Model of Capacity Utilization. A Reply to Dr. Committeri", in *Political Economy*, this issue.

[2] E. J. AMADEO, "Notes on Capacity Utilization, Distribution and Accumulation", in *Contributions to Political Economy*, vol. 5, 1986, pp. 83-94 and M. COMMITTERI, "Some Comments on Recent Contributions on Capital Accumulation, Income Distribution, and Capacity Utilization", in *Political Economy*, vol. 1, n° 4, 1987, pp. 161-186. Cf. also E. J. AMADEO, "The Role of Capacity Utilization in Long-Period Analysis", in *Political Economy*, vol. 2, n° 2, 1986, pp. 147-160.

[3] "The role of expectations was not considered in the original steady-state capacity utilization models", E. J. AMADEO, "Expectations in a Steady-State Model", *op. cit.*, p. 8.

[4] Note that for $v = 1$ equation (2) reduces to $u_t^e = u_{t-1}$ and equations (1)-(2) become $h_t^i = a + b(u_{t-1} - u^n)$. Consequently, the previous version of the model appears to be a special case of the present one.

Since expected and realized degress of utilization must coincide in steady-state equilibrium (i.e. $u_t^e = u_t = u_{t-1}^e = u_{t-1} = u^*$), and since the random term e_t has zero mean, the equilibrium values of u and h can be easily derived:

$$(5) \qquad u^* = (a - bu^n)/(c - b) \quad \text{and} \quad h^* = c\,u^*$$

As (5) makes clear, there is nothing in the model to ensure the equality between the steady-state equilibrium value of u and its normal level.[5] So the argument runs. This result, however, is somewhat surprising: if we assume (as Amedeo does) that u^n is a target which firms endeavour to achieve, how is it possible to have an "equilibrium" situation in which investors deviate systematically from their target?

In what follows, it will be shown that Amadeo's mechanism of expectations formation is incompatible with the idea that investors aim to achieve the normal utilization degree, so that the apparent contradiction between the assumption of a target degree of utilization and the systematic discrepancy between realized and normal degrees is reconciled simply by eliminating the former.

Before entering into our discussion, it is worth spelling out some assumptions which seem to underlie Amedeo's analysis: (I) Only one type of good is produced in the economy, and can be used both for investment and personal consumption; (II) Within the limit represented by the maximum attainable degree of capacity utilization (here expressed as the output: capital ratio), production is demand determined, and is carried out in cycles or "periods"; (III) At the beginning of each period, the volume of installed capital is given and does not change until the next period. At the same time, investors take their decisions on the basis of expectations about future events, apparently formed when investment decisions are taken; (IV) Investment plans (orders) are never revoked by firms and always realized; (V) At the end of the period, actual sales are determined by the multiplier mechanism; hence, abstracting from changes in inventories, the actual degree of capacity utilization is also determined.

In equation (1), h_t^i appears to be defined as the accumulation rate *actually realized* at time t (i. e. as the rate of change in the capital installed in t). This, in turn, can be viewed as the ratio between net investment orders and installed capital in t-1 or, in other terms, as the accumulation rate desired at time $t - 1$:

$$_{t-1}h_t^d = (_{t-1}K_t^d - K_{t-1})/K_{t-1}.$$

According to this definition, the expectation of u which enters the investment function will be formed in $t - 1$, i. e. when investment decisions

[5] "In a long-period average position, the expected and realized degress will be equal to each other, but they will not necessarily be equal to the normal degree of utilization", E. J. AMADEO, "Expectations in a Steady-State Model", *op. cit.*, p. 20.

are taken. This expectation can be expressed as the ratio between ${}_{t-1}X_t^e$ (i.e. the volume of sales firms expect to realize in t) and K_{t-1} (i.e. the volume of capital installed in $t-1$, which determines the potential output at time t):

(E1) $$ {}_{t-1}u_t^e = {}_{t-1}X_t^e / K_{t-1} $$

Note that this one-period-ahead expectation of u need not be equal to its normal level. Indeed, at time $t-1$ there is nothing firms can do to match their potential output with an abnormally low (or high) demand expected in t: this is so because investment decisions taken in $t-1$ can only influence the potential production in $t+1$.[6]

For this very reason, then, we would expect these decisions to be taken on the basis of demand expectations referred to $t+1$ onwards; as is clear, these expectations would be formed at time $t-1$, i.e. when investment decisions are taken.

Therefore, in principle, we should look at the two – (or more) – period-ahead expectation of u. Let us consider the two-period-ahead expectation first. This latter can be expressed as the ratio between ${}_{t-1}X_{t+1}^e$ (i.e. the $t-1$ expectation of sales to be realized in $t+1$) and ${}_{t-1}K_t^d$ (i.e. the capital to be installed in t, which is under the firms' control in $t-1$):

(E2) $$ {}_{t-1}u_{t+1}^e = {}_{t-1}X_{t+1}^e / {}_{t-1}K_t^d $$

Now, at least in principle, this expected u could be made equal to its normal level: given the expected volume of demand in $t+1$, it would always be possible to instal an "appropriate" amount of capital, in such a way as to achieve the normal utilization degree in $t+1$.

On the other hand, since demand *fluctuates*, investors could find it unprofitable to reach u^n at some specific point in time: instead, it is reasonable to suppose that potential output will be kept in line with the expected *peaks* of demand. Therefore, given a profile of expected demand in future periods, an accumulation pattern desired in $t-1$ would be defined to make the expectation of u (as formed in $t-1$) gravitate around a mean value u^n.

However, these possibilities are prevented by equation (2). In this equation, u^e is supposed to follow an adaptive pattern. Now, it is a well-known feature of the adaptive-expectations mechanism that at any given moment of time the two-or-more-period-ahead expectations are *exactly the same* as the one-period-ahead one.[7] Equation (2) therefore implies that

(2′) $$ {}_{t-1}u_t^e = {}_{t-1}u_{t+j}^e \quad \text{for all} \quad j > 1 $$

[6] If viewed in this light, it appears somewhat inappropriate to think, as Amadeo seems to do, that u^e reflects "long period" expectations.

[7] This is quite natural, because agents can use the only information available when expectations are formed. In $t-1$, the one-period-ahead expectation will take into account the available information represented by the actual values of the variable in $t-1$, $t-2$, etc.; the two-or-

In turn, from (2′) it follows that the percentage rate of change of expected sales between t and $t+1$ is equal to the accumulation rate desired in $t-1$:

$$\frac{{}_{t-1}X^e_{t+1} - {}_{t-1}X^e_t}{{}_{t-1}X^e_t} = \frac{{}_{t-1}u^e_{t+1}}{{}_{t-1}u^e_t}\,(1 + {}_{t-1}h^d_t) - 1 = {}_{t-1}h^d_t$$

In other words, given the rate at which investors desire to accumulate (as determined by equation 1), expected sales will grow *by definition* at the same rate, in such a way as to maintain the two-period-ahead expected u at the same level as the one-period-ahead expected u.[8] Therefore, (2) contradicts the assumption that u^n is a target for investors: indeed, even if at time $t-1$ the one-period-ahead expected u happened to be less than the normal one, demand expectations would prevent the two-or-more-period-ahead u from tending towards the normal utilization degree.

Amadeo's difficulties derive from imposing an adaptive-expectations mechanism on the degree of capacity utilization, which is clearly incorrect. The latter is a ratio whose denominator is a variable firm can control through their investment decisions, at least in the long period. Consequently, the expected u is not independent of the desired accumulation rate (we have, as it were, one degree of freedom). What firms cannot control, of course, is the future size of their market, which must be estimated. If, however, the behaviour of u^e is tied to an adaptive mechanism and investment decisions are determined by some rule (as in equation 1), the ensuing behaviour of expected demand will prevent u^e from converging on u^n.

In conclusion, Amadeo does not appear to answer the main point raised in my comments, since he has in fact changed the terms of the problem under discussion: if investors do not assume the normal utilization as a

more-period-ahead expectations, on the other hand, can only be the same as the one-period-ahead one, because agents do not have information about what will happen in t, $t+1$, etc. To show this, let us write (2) as:

$$\begin{aligned} {}_{t-1}u^e_t &= {}_{t-2}u^e_{t-1} + v\,(u_{t-1} - {}_{t-2}u^e_{t-1}) = v/[1 - (1-v)L]\,u_{t-1} = \\ &= v\,u_{t-1} + v(1-v)\,u_{t-2} + v(1-v)^2 u_{t-3} + v(1-v)^3 u_{t-4} + \ldots \end{aligned}$$

where L is the lag operator. When put it this form, equation (2) can be used to derive the expectation of u in $t+1$ as formed in $t-1$ (notice that the first term on the right-hand side is the *expectation* of u_t, which is *not* known in $t-1$):

$$\begin{aligned} {}_{t-1}u^e_{t+1} &= v_{t-1}u^e_t + v(1-v)\,u_{t-1} + v(1-v)^2 u_{t-2} + \ldots \\ &= v_{t-1}u^e_t + (1-v)\,[v\,u_{t-1} + v(1-v)\,u_{t-2} + v(1-v)^2 u_{t-3} + \ldots] \\ &= v_{t-1}u^e_t + (1-v)_{t-1}u^e_t = {}_{t-1}u^e_t \end{aligned}$$

Analogously, it can be shown that this equality holds for any expectation of u_{t+j} formed in $t-1$, where $j \geqq 1$.

[8] More in general, we have:

$$({}_{t-1}X^e_{t+j} - {}_{t-1}X^e_{t+j-1})/{}_{t-1}X^e_{t+j-1} = {}_{t-1}h^d_{t+j-1} \text{ for all } j \geqq 1$$

where ${}_{t-1}h^d_{t+j-1} = ({}_{t-1}K^d_{t+j-1} - {}_{t-1}K^d_{t+j-2})/{}_{t-1}K^d_{t+j-2}$

and where, by definition, ${}_{t-1}K^d_{t+j-2} = K_{t-1}$ for $j = 1$.

target, it is no surprise to find that the steady-state equilibrium degree of utilization will in general differ from the normal one.

This assumption, however, is not the one adopted by the authors to whom Amadeo refers (Steindl in particular), and would have to be justified on a different basis. If, on the other hand, we maintain that u^n is a target pursued by firms through their investment decision, it is intuitive that in a steady-state equilibrium investors will not deviate systematically from their target.

A final remark is in order. As long as the analysis is restricted to comparisons between steady states, no positive relationship between real wages and capital accumulation can seemingly obtain, if techniques are given. Since in steady-state equilibrium a normal utilization must prevail, there would be no room for any "acceleration" effect: given the wage-profit curve, any increase in the real wage rate must be associated with a decrease in the rate of profit and hence (if the usual assumptions on saving propensities are made) in the rate of accumulation. Do we have to conclude, then, that a rise in real wages does not stimulate growth? I think the answer cannot be based on steady states; in full keeping with Professor Vianello[9], I regard these states as a misleading basis for the analysis of accumulation. If, as Amadeo himself seems to think, such states can be seen as a particular case of "long-period positions",[10] why should we restrict the analysis of accumulation processes to these particular cases? After all, we *know* that actual accumulation processes do not conform to the picture of a steady-state equilibrium.

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[9] F. VIANELLO, "The Pace of Accumulation", in *Political Economy*, vol. 1, n°, 1985.

[10] Cf. E. J. AMADEO, "Expectations in a Steady-State Model", *op. cit.*, p. 7: "The differences between models based on the notions of steady states and centres of gravitation are not 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".

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