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THEORY OF OUTPUT GROWTH AND OF PER CAPITA OUTPUT GROWTH: WITH OR WITHOUT SAY'S LAW?

Introduction

In a majority of the recent writings on economic growth, the term 'growth' without further qualifiers is used to mean growth of *per capita* output, with a striking linguistic change relative to a couple of decades ago. This linguistic change reflects the exclusive concentration on the determinants of the growth of per capita output, which characterises modern Endogenous Growth Theory. The implicit, and sometimes explicit, message is that the growth of per capita output is the really important question in growth theory([1]). But the exclusive concentration on this question would not have happened, without the previous conclusion that the theory of long-run output growth is a solved problem, there being no doubt that long-run output growth is, with sufficient approximation, determined by the reinvestment of full-employment savings (or of the savings associated with a natural rate of unemployment or NAIRU). This also explains why little attention is given to distinguishing per capita output from output per unit of employed labour([2]).

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[1] . "...the determinants of long-run economic growth are crucial issues, far more important than the mechanics of business cycles or the countercyclical effects of monetary and fiscal policies" (Barro and Sala-i-Martin, 1995, p. 12). Such a view can however be disputed on the basis of evidence showing that long-run increases in average living standards do not increase happiness except to the limited extent to which they decrease physical pain (from hunger, cold, illness): on the basis of this evidence a recent survey concludes: "The results in this paper suggest that, in a developed nation, economic progress buys only a small amount of extra happiness....Unemployment appears to be the primary economic source of unhappiness. If so, economic growth should not be a government's primary concern." (Oswald, 1997, p. 1827, 1828) I take the opportunity to thank Mauro Caminati for some very useful comments.

[2] . This is much less acceptable when the possibility of high unemployment rates, and the possibility of adaptations of labour supply (and thus of the participation rate) to demand, are admitted, but the issue will not be discussed here, and for brevity I shall mean by 'per capita output' average labour productivity.

I want to go, to an extent, against the stream, and argue that, even if one were to concede that the really important question is the determinants of the growth of per capita output, one should still dedicate much more attention than is now on average the case to the question of the determinants of the growth of *aggregate* output. This is because (i) there are very good reasons to think that the correct theory of long-run aggregate output growth is not the one (output growth determined by the full employment of resources) accepted in the generality of Endogenous Growth models, and (ii) on the basis of the forces considered in those same Endogenous Growth models as affecting per capita output, a different theory of output growth can be shown to have relevant implications for the growth rate of per capita output as well. I discuss the second point before the first, because, for economists who believe that per capita growth is the really important issue, point (i) would be of limited interest if point (ii) were not valid. But before, Part I remembers the reasons why a different approach, admitting relevant effects of aggregate demand on output growth, is possible. This is done in the form of a criticism of an opinion to the contrary recently expressed by Robert Solow.

Part II then argues point (ii) by showing that the forces, which render the growth of labour productivity endogenous([3]) in Endogenous Growth models, all act the stronger, the faster is the growth of output. Therefore the moment the full-employment assumption is dropped and a possible autonomy of the evolution of aggregate demand is admitted, the growth rate of aggregate demand must be admitted to be an important influence on the growth rate of per capita output. Then another possible cause appears of differences among nations in the growth rate of per capita output: the different growth rate of aggregate demand.

Parts III and IV survey the main reasons to question the belief that the full employment of resources, or the theory that the economy gravitates around a NAIRU, are good starting points for the theory of growth. Part III discusses in particular the relevance of the speed with which the economy converges, if at all, toward the full employment of resources, and the criticisms of the supposed tendency of the economy toward a NAIRU. Part IV discusses the criticisms of the ability of the rate of interest to bring investment into equality with savings, and the support that the theory of general equilibrium can provide for Say's Law.

PART I
The possible role of demand in output growth

[3] . In the sense of depending, period by period, on the agents' decisions (the steady-growth result is therefore irrelevant to the meaning of 'endogenous' here, the growth of labour productivity is endogenous in this sense also in Arrow's model of learning-by-doing).

I.1. I would not be surprised if many, especially among the younger economists trained in mainstream departments, found it difficult to conceive of long-run output growth as determined by anything else but the full employment of resources (or the sustainable employment of resources, i.e. the one associated with the NAIRU: an issue which will be for the moment set aside). Mainstream teaching seems in fact to have adopted in recent years the view that this is the only theory worth teaching. For example the recent textbooks on growth by Barro and Sala-i-Martin (1995) or by Charles Jones (1998) never mention any non-neoclassical approach to growth.

I therefore start by indicating why and how a different approach is possible. A good way to do this is by commenting upon an interesting passage in a recent paper by Robert Solow (1997) on the state of macroeconomics, in which he, after reaffirming the faith in full-employment models (e.g. his own model) for the study of long-run growth and after admitting that in the short run there may be deviations from full employment, continues:

> One major weakness in the core of macroeconomics as I have represented it is the lack of real coupling between the short-run picture and the long-run picture. Since the long run and the short run merge into one another, one feels they cannot be completely independent. There are some obvious, perfunctory connections: every year's realized investment gets incorporated in the long-run model. That is obvious. A more interesting question is whether a major episode in the growth of potential output can be driven from the demand side. Can demand create its own supply? The magnitudes suggest that it would be awfully difficult for a surge of aggregate demand to generate enough investment to provide the capacity necessary to accommodate it. In special circumstances it might be done, say, in an economy that has a pool of labor (rural, foreign) that it can mobilize. It might also work if strong aggregate demand can induce a rise in total factor productivity (TFP). This may be less far-fetched than it sounds, if we recognize that a large part of TFP originates not in the research laboratory, but on the shop floor, as production workers figure out how to gain a little efficiency here and a little there. The demand-driven growth story sounds quite implausible to me under current conditions: but it is an example of the kind of questions that needs to be asked". (Solow, 1997, pp. 231-232)

It is a pity that Solow does not give more details on his reasons for the statement: "The magnitudes suggest that it would be awfully difficult for a surge of aggregate demand to generate enough investment to provide the capacity necessary to accommodate it". The opposite is clearly the case for *slowdowns* of aggregate demand: there is no impediment to a lengthy economic crisis discouraging investment and thus decreasing capacity to the lower level appropriate to the lower level of demand (and this by itself suggests a potentially important role of aggregate demand); but Solow appears to be generally wrong – unless one has in mind

exceptional growth rates of aggregate demand – also for *accelerations* of aggregate demand. I show this with a numerical example, crude but I think sufficient to make the point.

I.2. As a preliminary to the example, let us notice that an aspect of the functioning of industrial economies, which appears to be forgotten or underplayed in much current growth theory, is the *adaptability of productive capacity to demand* (Ciccone, 1990; Vianello, 1985; Garegnani, 1992; Trezzini, 1995; Serrano, 1995). This adaptability derives from the considerable variability of the degree of utilization of productive capacity.

Firms want to maintain spare capacity because that allows them to meet expected, or possible, demand fluctuations, or expected or possible growths of demand; and because very high rates of utilization cause higher average costs because overtime-labour and night-labour are more expensive. The first group of reasons for spare capacity means that firms will produce more at no extra average cost if only demand is higher on average than expected; and even the last reason is usually not sufficient to prevent an increase of production if the demand for the product increases, even if the price of the product remains constant, because in imperfectly competitive markets (the most frequent market form) the fear of losing market shares will make a higher degree of capacity utilization than the long-period optimal one become convenient in the short run – and this without any redistribution of income away from labour, rather the opposite being the more likely case because of the increased share of overtime wages.

Such variability of capacity utilization is of course what makes the production of goods capable of that rapid adaptation to changes in the level or composition of demand, which is usually observed in reality: as is well known from the accelerator principle, for durable capital goods a relatively small change in normal demand for the goods which utilize them, entailing a relatively small change in the desired stock of durable capital goods, may mean a very big change in the demand for newly produced durable capital goods; which also means a very big change in the demand for the specialized intermediate goods needed to produce those durable capital goods; and yet very rarely does one observe bottlenecks in production. This suggests that the variability of capacity utilization is considerable not only downwards – what nobody would deny – but also, up to limits rarely reached, upwards.

The implication of this variability is that the level of production is quite variable in response to variations in demand, not only for single industries, but also for entire sectors, in particular, for the capital-goods-producing sector, and – the moment one admits that the supply of labour is not usually fully utilised and can usually be increased (in the short period perhaps by overtime work) – also for the entire economy. (Obviously the possibility to accelerate the rate of production is due to the existence of inventories of intermediate goods, inventories which will be initially run down but will be then rapidly reconstituted by the increase itself of production.)

But if the level of production is so variable, then – concentrating now on the capital-goods sector, i.e. the sector whose production creates productive capacity – the production of

productive capacity, and therefore the rate of growth of productive capacity, must be considered determined by demand, so the evolution over time of the overall productive capacity of an economy must be considered, in an analysis of growth, the result of demand, rather than a determinant of production. The moment a potential independence is admitted of investment decisions from saving decisions (and few economists would deny it, even when they believe that however there *are* mechanisms which cause the former to gravitate toward equality with the latter), this influence of demand on capital accumulation can be seen as by itself an important reason to doubt the notion of a supply of capital determined by decisions to save.

I.3. To make such statements more concrete and also stress the cumulative effects of a higher or lower aggregate demand, let us come to the numerical example. This is based on a multiplier-accelerator model of a closed economy with public expenditure and a balanced budget, and with – contrary to the common practice in multiplier-accelerator models – depreciation and a distinction between gross and net investment(4). The actual capital stock is K, the desired capital stock is K*. Net investment I_N in each period t is performed to bring the capital stock at the beginning of the period, K_t, to its desired level by the end of the period, i.e.at the beginning of the next period, K^*_{t+1}. The desired capital-output ratio K^*_t/Y_t is 1, and firms are assumed to be myopic or very prudent and, when deciding investment for period t, to expect for period t+1 the level of gross output just observed, i.e. Y_{t-1}. Thus $K^*_{t+1}=Y_{t-1}$ and *net* investment is governed by $I_{Nt}=Y_{t-1}-K_t$, while *gross* investment I_t is equal to net investment plus depreciation, which is assumed to be 10% of K_t. Investment plans are realized and therefore $K_t=Y_{t-2}$. Consumption is equal, with a one-period lag, to 8/9 of after-tax income, and the state is assumed to be able every period to tax for an amount exactly equal to public expenditure, so $C_t=(8/9)(Y_{t-1}-G_{t-1})$. Output is assumed to adjust very rapidly to demand so that in every period Y=C+I+G.

The autonomous role in aggregate demand is taken by public expenditure. The economy is assumed to be initially stationary, with Y=1000, K=K*=1000, I=100, I_N=0, G=100, C=800. Then from period 0 onwards public expenditure starts increasing at a rate of 2% per period. The evolution of the economy is described by the following table:

t	G_t	$K^*_{t+1}=Y_{t-1}$	$K_t=K^*_t$	deprec.$=0{,}1\cdot K_t$	I_N	I (gross)	C_t	Y_t	Y_t-G_t
-2	100	1000	1000	100	0	100	800	1000	900
-1	100	1000	1000	100	0	100	800	1000	900
0	102	1000	1000	100	0	100	800	1002	900

4 . On the contrary the usual simplification is maintained of giving no role to inventories and to their fluctuations.

1	104.04	1002	1000	100	2	102	800	1006.04	902
2	106.12	1006.04	1002	100.2	4.04	104.06	801.78	1011.96	905.84
3	108.24	1011.96	1006.04	100.60	5.92	106.52	805.19	1019.95	911.71
4	110.41	1019.95	1011.96	101.20	7.99	109.19	810.41	1030.01	919.60
5	112.62	1030.01	1019.95	101.99	10.06	112.05	817.42	1042.09	929.47
6	114.87	1042.09	1030.01	103.00	12.08	115.08	826.20	1056.15	941.28
7	117.17	1056.15	1042.09	104.21	14.06	118.27	836.69	1072.13	954.96
8	119.51	1072.13	1056.15	105.61	15.98	121.59	848.85	1089.95	970.44
9	121.90	1089.95	1072.13	107.21	17.82	125.03	862.61	1109.54	987.64
10	124.34	1109.54	1089.95	108.99	19.59	128.59	877.90	1130.83	1006.49
11	126.82	1130.83	1109.54	110.95	21.29	132.24	894.66	1153.72	1026.90
12	129.36	1153.72	1130.83	113.08	22.89	135.97	912.80	1178.13	1048.77
13	131.95	1178.13	1153.72	115.37	24.41	139.78	932.24	1203.97	1072.02
14	134.59	1203.97	1178.13	117.81	25.84	143.65	952.91	1231.15	1096.56
15	137.28	1231.15	1203.97	120.40	27.18	147.58	974.72	1259.58	1122.30
16	140.02	1259.58	1231.15	123.12	28.43	151.55	997.60	1289.17	1149.15

The table (and its continuation not reported here) shows that the growth of public expenditure stimulates a growth of Y which induces a growth of I at a rate which grows up to about 2.8% (in periods 11 to 14) and then tends slowly (with damped oscillations) toward 2%, with an associated growth of Y and of K which also becomes initially higher than 2% and then tends toward 2% (it is about 2.3% in the last periods of the table); thus after 15 periods the capital stock has grown by over 20%.

Very importantly, the example also shows that in order to achieve this result *there is no need for decreases either of consumption, or of the average propensity to consume*: the increase of the rate of growth of capital without decrease of the average propensity to consume is made possible by the increase of Y, which makes it possible to increase I while also increasing C([5]). So, unless an economy is already at the maximum level of production, it is not true that in order to accelerate the growth rate of capital accumulation the average propensity to save must increase; in most historically observed situations (apart perhaps from very poor underdeveloped agricultural countries) there has been and there is room for increases of investment which will stimulate capacity utilization, so that output from the given capacity will increase, and there will be room for both more investment and more consumption.

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[5] . The *share* of C_t in Y_t slightly decreases, from 80%, to 77.4% in period 16, but only owing to the one-period lag between receipt of income and its expenditure on consumption; without such a lag one would have obtained analogous results as to the growth of Y and of C, without any decrease of C_t/Y_t; in either case, contrary to the standard neoclassical view, there is no need for an initial decrease of consumption, in order to permit an increase of investment.

The table also shows that there is no reason why this growth process should run against bottlenecks. The average Y/K ratio remains all the time close to 1, arriving at most at about 1.05, which means on average a capacity utilization only 5% greater than the normal one, something very easily obtainable. The utilization rate *in the capital-goods industry* becomes initially greater than that, of course (because when gross investment increases, it increases initially percentwise more than Y); but a more detailed example, separating sectors and including hypotheses on the forces affecting the allocation of investment among sectors, would have been necessary in order to estimate by how much. What one can say on the basis of this example is that it cannot increase by more than 20% because, before the growth process begins, the capital goods industry (assuming there too the capital-output ratio to be 1) employs 1/10 of the capital stock, and if this ratio remained the same afterwards, the utilization ratio in the capital goods industry would rise to 20% above normal; but one can be certain that in fact it will rise much less, because the higher capacity utilization will induce net investment to go in greater proportion toward the capital goods industries, whose productive capacity will therefore increase faster. And anyway, precisely because of the likelihood of greater fluctuations of demand in the capital goods industry, this industry can be presumed to be particularly well prepared to adapt production to wide fluctuations of demand.

So the assumption that a faster growth of the autonomous components of aggregate demand (analogous examples might be construed for increases of exports, or of state-controlled investment in nationalized firms) will bring about a 2%-faster growth rate of average productive capacity appears to meet no obstacle.

The reasoning is just as applicable, or even more applicable, to the case where aggregate demand and production were not initially stationary, but were growing at a rate g and this rate then becomes g+2%. Even more applicable, because the positive growth rate g motivates a reason for the existence of planned underutilised capacity which would not hold in a stationary economy: the construction of bigger plants than necessary at the moment of completion, in the expectation of future increases of demand.

A simple reversal of the reasoning (assuming that the growth rate of the autonomous components of aggregate demand becomes 2% lower) shows that an insufficient growth rate of demand may be responsible, after a few years, for a very considerable loss of potential productive capacity, a loss easily resulting in structural unemployment, but otherwise not easily perceptible, because not visible.

The historical observation that productive capacity is not greatly underutilized for very long periods can then be explained as due to the fact that, if productive capacity is excessive relative to demand, then net investment decreases and may becomes negative, the older plants are closed down, and productive capacity shrinks or increases at a slower rate than demand, thus tending to adapt to demand. I think we are seeing this process happening now.

Unless one is thinking of *increases* of the growth rate of aggregate demand of much more than two percentage points, it seems therefore impossible to agree with Solow on the presumed difficulty demand would have in creating its own supply. For the opposite cases of prolonged *slowdowns* of the growth of aggregate demand, there can be no doubt as to the (cumulative!) effect this has on the loss of potential capital accumulation.

I.4. It might be objected that my example discusses only the adaptation of capital, while – strangely enough – in the passage quoted above Solow appears to have in mind above all a difficulty with finding additional labour. I say strangely enough, because for an economist like Solow who accepts the neoclassical theory of distribution with the associated conception of capital-labour substitutability, a given level of employment ought not to be an obstacle to an acceleration of capital accumulation, the latter ought only to entail an increase of the ratio K/L([6]).

But even in a non-neoclassical approach, where the real wage were considered given and thus also relative prices and technology were essentially given (as in the numerical example presented above), and where therefore a necessity would arise to increase employment if output growth is faster than the growth of labour productivity, Solow's worry appears to be unwarranted in most cases. In the short period, there is nearly universal agreement on the fact that official unemployment rates, besides being always positive, hide the presence of hidden unemployment, and that the rate of participation increases if labour demand increases; this is indeed part of the accepted explanation of Okun's Law; furthermore, there generally is some readiness to accept overtime work among already employed workers. If one turns to the ample time intervals relevant for the theory of long-run economic growth, one observes clear signs of a (spontaneous or engineered) tendency of the supply of labour to adapt to the demand for labour, so that capitalist economies seem to have been always able to avoid a labour supply constraint. Agricultural underemployment, other pre-capitalist sectors, domestic labour have historically supplied the labour reserves necessary to the industrial revolution and to subsequent growth when the spontaneous increase of population was not enough. When that was not sufficient (as in post-war Germany) or non-existent (as in the case of the USA), there have been massive and carefully regulated immigration flows, or sometimes policies promoting fertility (or combating fertility, as now in China). It would seem therefore that historically for labour supply too, it is true that in the long run demand has created – spontaneously or through policy interventions – its own supply. The present pressure for immigration from poorer countries toward the industrialized ones suggests that there is little obstacle to the same being true now and in the foreseeable future.

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[6] . And for the short run, it is Solow himself who has repeatedly argued that the observed unemployment is involuntary, implying little difficulty with increases of employment.

Furthermore the policy question behind all this, i.e. whether the state should or not be assigned a relevant role of regulation of aggregate demand, becomes relevant above all in the periods of recession or crisis, when there is a greater than usual excess of labour supply.

I.5. The above was intended to give a first idea of why it is possible to conceive long-run output growth as determined by the evolution of aggregate demand, with labour supply and capital accumulation *adapting* to aggregate demand, rather than *determining* it via the investment of full-employment savings([7]). I proceed now to show that this different approach to output growth is also relevant for the question of the rate of growth of per capita output or labour productivity, according to the determinants of the latter rate considered in Endogenous Growth theories.

PART II
Endogenous growth without the full employment of resources

II.1. If we look at the reasons which in the recent models of endogenous growth endogenise technical progress, we can see that *the force of their action is influenced by the rate of growth of total output; so, whether this rate is or not determined by the investment of full-employment savings can make a significant difference to the rate of growth of per capita output*.

One of these reasons can be left aside as unacceptable: the one proposed by Jones and Manuelli (1990). This is the hypothesis of a CES aggregate production function, which has the property that the marginal product of a factor is bounded above a strictly positive value. It had already been noticed as a possibility by Solow (1956) but then left aside in subsequent literature, evidently because implausible. And indeed, even neglecting for the sake of argument the illegitimacy of the treatment of capital as a single factor homogeneous with the consumption good, and therefore with a well-defined marginal product, the hypothesis that the marginal product of capital never goes below a strictly positive value has no economically acceptable interpretation([8]).

Synthesizing, the other reasons utilised to endogenise the growth of per capita ouput are:

investment in the production of new knowledge

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[7] . Cf. Garegnani and Palumbo (1998) for further implications of such an approach and for some remarks on historical evidence supporting it.

[8] . The implication of the CES functional form that production can be positive even when L=0 deprives the CES production function of plausibility. A production function of the form $Y=K^{b}L^{1-b}+aK$ is also able to avoid the tendency of the marginal product of capital to go to zero when K/L increases; but it is analogously devoid of acceptable economic interpretations because again it allows production to be positive even when L=0.

investment in the production of human capital
externalities connected with the expansion of production, or with production itself (e.g. learning by doing)
division of labour (increase of specialisation) producing scale economies.

In the literature on underdevelopment, especially with Rosenstein-Rodan and Nurkse, besides a considerable stress on indivisibilities (e.g. in infrastructures such as roads or ports, or also in the minimal dimensions necessary to utilise the more modern technologies) which might perhaps be assimilated to the influence of market size on the division of labour, an important role is also assigned to technological gaps, which may require, in order to be overcome, specific investments for modernization (also in education).

Let us then examine the influence of the output growth rate on these causes of per-capita output growth.

II.2. Let us start by considering learning-by-doing *à la* Arrow (1962).

If one is to leave a role to aggregate demand, then as said above the full employment of labour should not be assumed (the variability of labour employment in the short period is a prerequisite for a variability of capacity utilization in response to variations of aggregate demand). Should one then assume a relationship between employment and the real wage? Keynes's approach was to assume a decreasing labour demand curve even in the short period, thus maintaining a univocal decreasing relationship between real wage and Y. But it has been repeatedly noticed (e.g. Zenezini, 1990; Brandolini, 1995)([9]) that empirical evidence does not accord with this construction for the short period. The Cambridge critique of neoclassical capital theory shows that the labour demand curve is anyway an unacceptable notion([10]). On the other hand, the more and more widely accepted NAIRU approach shows that economists are prepared to admit the role of bargaining strength and other socio-political factors in the determination of the real wage. On this basis, I propose now to assume a given real wage (which increases through time in proportion with labour productivity), which determines technical choices, so that it is as if there were in each period fixed technical coefficients. This has the advantage of allowing us to dispense with that indefensible theoretical construct, the aggregate production function. But in order not to lose all contact with New Growth models, let us still assume a single output (corn produced by corn and labour), as an approximation to a

[9] . Among older studies, Dunlop's and Tarshis' objections to Keynes are well known.

[10] . What should be maintained fixed as far as the employment of factors other than labour is concerned, when attempting the determination of the curve of the marginal product of labour? A given vector of capital goods would make no sense: their quantities would be susceptible to very quick change and so can give no indication of the persistent effect of changes in the real wage; a given value of capital K is an indefensible notion because values change with the real wage. Cf. Petri (1997).

multi-sector economy where aggregation in value terms is possible as long as relative prices are given. Let us then suppose

(1) $Y = AK = BL$.

Let us assume, as is often done, that technical progress is of the purely labour-augmenting type([11]), i.e. that A is not affected by technical progress; Arrow's learning-by-doing (depending, as is well known, on cumulated experience measured by cumulated investment) can then be formalized in this approach by assuming that, at the aggregate level, B is an increasing function of the level reached by the accumulation of capital:

(2) $B = K^{\beta}$ with β a positive constant.

Then one obtains([12])

(3) $Y/L = K^{\beta}$.

So per capita output increases with the growth of the stock of capital([13]). It is then clear that, whatever accelerates the growth of K, also accelerates the growth of Y/L. If the growth of

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[11] . This implies assuming that the *kinds* of goods produced do not change but that ways are found to produce them with less and less labour. This obviously unrealistic hypothesis, like others in this Part II, is only made for the purpose of showing to New Growth theorists, with as little a departure from their models as decently possible, that their own views as to the determinants of technical progress should induce them to reconsider the theory of output growth. Such a reconsideration, if they will embark upon it, will take them to the debates in the theory of value, capital and distribution, and will hopefully help growth theory to regain that taste for theoretical rigour which is so patently lacking when one postulates e.g. that variations in the stock of ideas of an economy can be measured by a scalar.

[12] . Romer (1986) assumes a knowledge-producing activity of firms, with knowledge spillovers to other firms, but the final result is, as is well known, extremely similar to Arrow's and, if one assumes fixed coefficients as here in equation (1), then equations (2) and (3) appear also to represent Romer's ideas as to the final result of what in that article he sees as the causes of technical progress (with the well-known difference that Arrow would assume $\beta<1$ while Romer would assume $\beta>1$). This may be the place to add a critical comment on that article. Romer assumes that the consumption good is produced (by a given number of firms) by firm-specific knowledge k, general knowledge K, and a vector $\mathbf{x}$ of other inputs (e.g. land, capital, labour) given in amounts; and that each firm produces private knowledge via the use of its own private knowledge and of forgone consumption. The details of these assumptions are difficult to justify (and yet no justification is offered): for example, why doesn't general knowledge K also influence the production of private knowledge? why isn't the production of capital goods, which is indispensable at least to compensate for depreciation, explicitly modelled? why aren't the rentals of the given factors included in the costs? why is there no mention of other factors in the production of knowledge? why (in a model of long-run growth!) is the number of firms given? why are the amounts of other factors in the vector $\mathbf{x}_i$ given *for each firm* and not only in the aggregate? above all, can we measure knowledge quantitatively so as to be able to say that knowledge has e.g. doubled? Clearly something strange has happened in macroeconomics, with the acceptance by 'top' journals of articles such as this one, which introduce such bold and dubious assumptions without giving a justification.

[13] . If the growth rate of K is constant, the growth rate of Y/L is constant, decreasing, or increasing depending on whether β is equal to, less or more than 1, but this is of limited interest here;

capital depends on the growth of aggregate demand which at least partially depends on autonomous elements (e.g. exports), then the growth rate of aggregate demand will influence the growth rate of Y/L.

II.3. Since in the above model it was assumed that Y/K was constant, it would have been equivalent to assume that B was an increasing function of Y rather than of K. This means that the same approach may also be viewed as one possible simple way to formalize a positive influence on output of the scale of production, and therefore of externalities or increasing returns connected with 'the size of the market'. One sees at a glance – what was intuitive – that a faster growth of output means a faster growth of Y/L.

Romer (1987) tries to capture the increasing-returns effects of an increasing 'division of labour' due to expansion of the size of the market, via a more micro-founded approach. Here the production function for final output is the same as in the more often quoted Romer (1990): output is produced by labour and by a number of capital goods of different design, whose productivity increases with the increase in the number of designs: the same stock K of capital, if subdivided among a greater number of different types of capital goods, counts as more capital. But rather than the resource-consuming production of new designs as in Romer (1990), it is the scale of aggregate output that determines the number of types of capital goods utilised, owing to U-shaped average cost curves in the production of capital goods, which set a limit to the convenience of specialisation. The functioning of the model is such that in the end it is as if final output were produced by a production function of the usual type $Y=K^{\alpha}(AL)^{1-\alpha}$, where A is the number of different types of capital goods, so one is formally back to labour-augmenting technical progress([14]).

So one should find here too that an autonomous role of aggregate demand influences the growth rate of Y/L. In fact Romer (1987) concludes the analysis of the model as follows: "any change that leads to an increase in savings – for example a tax subsidy, a decrease in the rate of impatience ρ, or a decrease in the intertemporal substitution parameter σ – will cause growth to speed up; the rate of exogenous technological change will appear to increase" (p. 62). But the increase in savings brings about this consequence only because it increases the growth rate of output. Anything else that increases the growth rate of output will have the same effect; Romer only discusses increases in savings *brought about by a higher average propensity to save* because he assumes the full employment of the (exogenously given or exogenously growing)

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even when $\beta<1$ there is indefinite growth of Y/L, and the reason for wanting to obtain a constant growth of Y/L is only the determination of steady states, whose empirical relevance is far from established and a priori highly doubtful on theoretical grounds, given the difficulties of aggregation and of intertemporal comparisons of a Y including all the time new products.

[14] . "..the economy will behave as if there is a form of exogenous, labour-augmenting technological change" (Romer, 1987, p. 61-2).

supply of labour. The discussion of Part I has shown that there is a way to increase savings without needing an increase in the propensity to save: by stimulating the growth of aggregate demand and letting Y adapt via increases in the utilization of productive capacity.

II.4. Let us turn to human capital. In Lucas's formalization of the role of human capital the production of human capital requires no input apart from human capital, and there is no depreciation of human capital, what is not plausible. But these limits of Lucas's formalization are overcome by Rebelo (1991):

$$Y=\psi K^{1-\alpha}(uHL)^{\alpha}$$

$$\dot{H}=(1-\psi)K^{1-\beta}((1-u)HL)^{\beta}-dH$$

$$\dot{K}=s_K Y-dK$$

where H is aggregate "human capital"([15]). Rebelo (1991, pp. 508-510) like Lucas assumes that L is constant, and shows that one obtains again Lucas's result, that an increase of the fraction of

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[15] . This treatment of human capital again confirms the lax standards of rigour in some influential New Growth models. How legitimate is the representation of human capital as influencing the efficiency units of labour through a multiplicative effect HL? Neither Lucas nor Rebelo pose the question. Treating human capital as a factor of production in the usual sense would imply that human capital should run against decreasing returns when added to a constant quantity of labour. This multiplicative approach has been probably aided by the inherent vagueness of the notion of 'human capital', which has to do with acquiring know-how, something different from increasing the amount of an input. The correct analogy seems to be with software: adding human capital is similar to adding more or better software to a computer. But then different 'quantities' of human capital mean that one is dealing with different *kinds* of labour, and aggregability and measurement of increases of the stock of human capital are highly dubious. Several authors write that this multiplicative approach has been suggested by studies (e.g. Mincer) showing that for each extra year of schooling wages increase by approximately the same percentage, 10% for some authors, 7% for others. Obviously a non-neoclassical economist would argue that wage differentials are not due to differences in marginal products, and the capital-theoretic criticism would support such a stance. But even within a neoclassical framework that justification appears questionable. Education changes one's skills, i.e. changes the kind of labour one offers, so in a supply-and-demand approach relative wages depend on the relative scarcities of the different kinds of skills, and it will be the choices of individuals which will alter relative scarcities until an equal convenience of investment in education is reached; in other words, the 'marginal product' of an extra year of education might well be decreasing in the sense that an increase of K per person and of the 'amount of education' (assuming it were measurable) per person in the same proportion might increase output less than proportionally, but in an economy where different degrees of education coexist, since different skills are not substitutable in fixed proportions, if the supply of the more highly skilled labour is sufficiently decreased, its marginal product and wage will increase, and this will indeed happen until the rate of return on one more year of education becomes the one desired by consumers: so within a neoclassical framework the observed marginal product of education reflects consumer choices and not a *technological* property of that marginal product. The assumption that without human capital the marginal product of labour is zero also appears strange. Furthermore one obvious objection to these

labour power assigned to the production of human capital increases the growth rate of output and thus, since labour employment is constant, also the growth rate of labour productivity.

Here the role of the full employment assumption is that of making it necessary to choose between more production of current output, and more production of human capital. The admission of the generalized presence of unused resources means that it is possible to have more of both, or less of both, depending on the evolution of aggregate demand. The increase in public expenditure considered in the example of §I.4 might for example be an increase in education expenditure, thus bringing about both a higher growth rate of Y and of H.

But even admitting that the destination of resources to education is primarily the fruit of private choices([16]), a positive influence of the evolution of aggregate demand on educational attainments in all likelihood exists. The 'production' of skills owing to private investment is responsive both to employment opportunities, and to income, and both are influenced by aggregate demand. The incentive to acquire specializations is higher when there are good job prospects for them; and a higher level of employment is in all likelihood conducive to more schooling, because more families can afford to send their children to school for more years. Also, some training is performed inside firms, and as employment increases, firms will train a greater number of workers. Even more than for general labour supply, skilled labour supply must be seen as largely adapting to demand.

Therefore a higher level of employment and of Y, and a higher growth rate of aggregate demand, can be trusted to go together with higher average levels of education, and hence, if these are believed to increase labour productivity, with a higher labour productivity.

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models is that physical capital does not expand only or mainly quantitatively, it changes qualitatively all the time, it *embodies* a technical progress which cannot be reduced to human capital, so human capital can be at most one part of the story, contrary to Lucas's focus.

[16] . Endogenous Growth models determine the private allocation of resources between production of goods and production of education on the basis of full-employment consumer choices endowed with perfect foresight. The closest one can remain to these models when admitting a role of aggregate demand is by reinterpreting labour employment as determined by labour demand rather than equal to labour supply (labour supply must then be assumed unlimited or adapting), by reinterpreting Y as determined by aggregate demand rather than reflecting the full employment of resources, and then by assuming that income distribution, although not determined by a neoclassical equilibrium, is nonetheless exactly what would be determined by the model if labour employment corresponded to the equilibrium on the labour market, and that the evolution of Y, although determined by non-neoclassical forces, is correctly predicted. The effect of the autonomy of aggregate demand on the degree of utilization of capacity (and hence on technology) must also be considered of secondary importance. The artificiality of this reinterpretation has persuaded me not to propose it as the general guiding line of Part II, but readers are welcome to consider it if they find it useful. In fact when one questions the correctness of the neoclassical approach to distribution and to growth, then also the decisions as to education (and, in other models, the decisions as to production of knowledge) will have to be explained differently.

II.5. I turn to investment in the production of knowledge. That the evolution of knowledge may be measured by a scalar is of course nonsense; but even interpreting 'knowledge' as simply an index of labour productivity, and even leaving aside the index problems in measuring the evolution of labour productivity in the face of changes in the quality and kinds of goods produced, still the assumption that increases of labour productivity may be connected by a production function to the resources dedicated to research, and furthermore by a production function which remains unchanged for very long periods, appears at least for the moment to be based purely on an act of faith which goes against the intrinsic unpredictability of discoveries; so steady growths (or, in more recent literature, constant growths, cf. e.g. Jones, 2000) derived on the basis of this assumption appear to me to have very little meaning. So here even more than for the other arguments I am interested in the basic insight rather than in the precise formalizations which have appeared in the Endogenous Growth literature. The basic insight is that advances of knowledge increase labour productivity but require resources to be produced. Here, again, the role of the full employment assumption is that of establishing a trade-off between producing more output or producing more research; a trade-off which no longer can be presumed to exist if one admits the generalized presence of unused resources whose level of utilization depends on the evolution of aggregate demand.

Like for human capital, the variability of output and of its growth rate means that it will generally be possible to conceive of higher levels and growth rates of resources dedicated to research, without any need to slow down capital accumulation nor consumption. Again, one may refer to the example of §I.4, imagining now that the increase of public expenditure goes to finance scientific research. But also, again like for human capital, one can argue that private resources destined to research will increase if there is an increase of Y. It is not only that the returns from patents will increase if an invention is utilized more because the productions for which it is used are operated on a larger scale, what might motivate an increase of the share of output dedicated to research; but even with a constant share of output dedicated to research, if output is bigger, so will be the amount of resources dedicated to research; and the whole point about an autonomous influence of aggregate demand is that, of two economies starting from the same size, the one with the more rapidly growing aggregate demand will in subsequent years have the bigger output([17]).

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[17] . The 'non-scale' recent literature (cf. Jones, 1999, for a simple characterization) argues that, given the share of output going to research, a bigger output does not mean a higher rate of growth of labour productivity if the increase in output goes together with a proportional increase in the variety of goods produced, and if reseach is sector-specific and with no spillover to other sectors. There is no doubt something to the insight behind this argument, but it can hardly be used to deny that a larger economy dedicating more resources to research will be advantaged by that. The different size of the economy is what made it easy for the USA to get ahead of the USSR in military technology, by dedicating to military research a much larger budget.

As to technological gaps, the higher the average degree of utilization of capacity, and therefore the higher is Y for each given level of capital accumulation, the greater will also be the share of Y which can be dedicated to the modernization of the economy, with the result that the technological gap can be overcome in less time.

Therefore, on the basis of their own hypotheses as to the determinants of the growth of labour productivity, endogenous growth theorists must admit that the question, whether one should accept the full (or NAIRU-level) employment of resources is a central question for the explanation of the growth rate of per capita income.

PART III.
Full employment or NAIRU? Some first doubts.

III.1. What has been argued in Parts I and II only indicates the relevance of the question of the determinants of output growth; one might agree, but then add that there are good reasons to accept the full or NAIRU employment of resources in long-run output growth theory.

But is that really so? That this is what apparently a majority of macroeconomists think is obviously no guarantee. Science does not proceed on the basis of majority voting. Let us therefore ask whether the exclusion of a relevant role of aggregate demand in long-run output growth theory is really solidly based.

Some doubt is immediately raised by the empirical observation of the numerous historical episodes of output growing, for many years in a row, at a rate in all likelihood much inferior to the potentially attainable one. Besides the Great Depression of the 1930s, one can mention the European unemployment since 1974: it is difficult to believe that unemployment rates above 10% imply no potential for greater output expansion, especially when one observes that in those same years an industrialised nation like Japan, with at least the same dependence upon oil imports, was attaining much higher rates of growth until 1990. Another obvious case is Japan after 1990([18]).

III.2. By themselves, these episodes might be judged insufficient to undermine the theory that market economies spontaneously *tend* to the full employment of resources: it might be argued that this tendency can sometimes meet relevant obstacles which prevent it from working properly, even for many years in a row.

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[18] . I am not claiming that mainstream macroeconomics is unable to find explanations for these episodes; I only claim that resources were underutilized and therefore policies, maintaining aggregate demand higher than it was, would have ensured a higher utilization of resources and higher growth rate.

But once this is admitted, then the exclusion of a relevant role of aggregate demand in long-run output growth becomes very hard to defend: one would have to argue that the periods of underemployment growth are compensated by periods of overemployment growth, so that the trend is sufficiently correctly approximated by an assumption of normal frictional unemployment only (which is the practical meaning of full employment); and arguments of this type are not very easily producible.

Let us in fact consider the IS-LM model which, as shown by current textbooks, remains the core of mainstream macroeconomics. The acceptance of this model makes it possible to argue – if the money supply can be considered sufficiently exogenous – that persistent unemployment is ultimately caused by the downward rigidity of money wages, which impedes the working of the so-called 'Keynes effect' i.e. the effect of variations of the price level on aggregate demand through their effect on the demand for money, hence on the interest rate, hence on investment. The well-known argument is that if money wages decreased in the presence of involuntary unemployment, this would induce a decrease of the price level and then, through the 'Keynes effect', an increase of investment and thus of employment. (The Keynes effect is used against Keynes.) But in order to pass from this conclusion to the thesis that Keynes's analysis is only the explanation of the fluctuations around a trend which is sufficiently close to the one of Solow's model, it is necessary to argue that money wage rigidity is not very relevant, and that the deviations from full employment are not very great, and compensated by deviations of opposite sign; and there is nothing in the model which authorizes such an argument. First, there is nothing in the IS-LM model which authorises the thesis that, once a period of unemployment caused by a recessionary shock has ended, there will be a period of overfull employment to compensate for it. Second, the observed frequent persistence of levels of unemployment not easily explainable as frictional or voluntary would rather suggest – within this model – that the downward rigidity of money wages is so strong, as to maintain the economy far from full employment most of the time; and since, given money wages, according to IS-LM theory (as traditionally conceived i.e. coupled, like in Keynes, with a decreasing labour demand curve) the real wage (and hence employment) is determined by the price level which depends on the level of aggregate demand, it is the evolution of the latter which is in the end responsible for the level and rate of growth of output.

Furthermore, the working of the 'Keynes effect', which should bring the economy back to full employment if money wages were flexible, relies crucially on the assumption of a significant influence of the interest rate on aggregate investment, and, as will be argued in Part IV, this assumption founders on both empirical and theoretical grounds. But before getting to this issue, it is opportune to discuss the NAIRU approach.

III.3. For theories of growth which deny the relevance of autonomous elements of aggregate demand, the NAIRU approach has two advantages. The first one is that, as mentioned

above, there are solid criticisms, both empirical and theoretical, of the decreasing labour demand curve; the NAIRU approach, increasingly adopted in recent years, does not need a decreasing labour demand curve in order to argue that the economy will anyway gravitate around a definite rate of unemployment; it can therefore be an alternative basis for denying a long-run influence of aggregate demand on growth, since it means replacing the full employment of labour with the NAIRU.

The second one is that the NAIRU approach to inflation (as distinguished from the natural-rate approach which is based on the tendency to full employment, i.e. to frictional unemployment only) makes it possible to argue that the periods of unemployment lower than the NAIRU level will be compensated by a similar number of periods of unemployment higher than the NAIRU level, if monetary growth is constant.

But, to start with, the adaptability of labour supply to labour demand (cf. §I.4 above) weakens any attempt to determine a NAIRU growth path independent of autonomous aggregate demand influences.

Furthermore, for empirical reasons the NAIRU approach is encountering considerable opposition even among otherwise mainstream economists. A growing number of studies concludes that there is no stable relationship between inflation and unemployment, and that the notion of a rate of unemployment, beyond which inflation would continually accelerate, is contradicted by the econometric evidence (cf. e.g. Setterfield et al. (1992), Rowley (1995), Eisner (1996), Coen et al. (1999), Lindbeck and Snower (1999), Solow (2000), Stirati (1999)). Ray C. Fair, in the most recent (Fair, 1999) of a series of contributions against the notion of a Phillips curve, argues that empirical evidence shows that increases of employment raise the price level *una tantum*, with nearly no acceleration of inflation, and that an econometric experiment hypothesizing a decrease of the interest rate and increase of employment in Germany from 1982 to 1990 shows that it would have been possible to decrease the rate of unemployment in Germany by 1% (and increase production by 2,14%) during all those years, with an increase of the rate of inflation, after 8 years, of only 0,23%. Serious doubts can also be advanced on the internal consistency and on the stability of the models used to determine the NAIRU (Sawyer, 1997).

III.4. Anyway the increasing adoption of the NAIRU approach in place of the monetarist theory of a natural rate of unemployment is interesting: it indicates that economists find it increasingly difficult to explain unemployment (in excess of frictional unemployment) as essentially voluntary (in the sense that the unemployed workers are supposedly unwilling to work at the ruling wage), and increasingly admit the need to interpret inflation as mostly cost, rather than demand, inflation and therefore reflecting a distributive conflict. There is thus an interesting *rapprochement* between the positions of mainstream and of conflictual economists: unemployment is more and more viewed as influencing the bargaining strength of the world of wage labour vis-à-vis firms.

But then the undefinability or impermanence of the NAIRU should not be surprising, for at least two reasons.

The first one is that, once it is admitted that firms are compelled to fix cost-covering prices and that therefore, *given the other costs*, an increase in monetary wages greater than the increase of labour productivity obliges firms to raise prices, the 'given-other-costs' clause is clearly crucial, and most of the times illegitimate. Among the other costs there are: interest rates; the salaries of white collar workers, of managers, of external consultants (e.g. lawyers); taxes; public utilities' prices; the prices of imported inputs which depend *inter alia* on the exchange rate. Therefore there are several degrees of freedom which make it possible that as money wages increase there may be no need for firms to increase prices, or that there be inflation in spite of no money wage increases. These degrees of freedom are of course known to the parties to the bargaining over wages and inevitably the likely policies toward those other costs will be taken into account in the bargaining over money wages, which should therefore be seen as capable of influencing the real wage too, and not only money wages.

The second strictly connected reason is that in the relative bargaining strength of labour and firms there enter many institutional and political elements, such as the preferences of government and of the monetary authorities, the degree of unity of labour and of firms in the bargaining process, the expectations of trade unions on the effects of their action on unemployment. Thus it is conceivable that a decrease of unemployment may not induce trade unions to ask for wage increases in excess of labour productivity, if they esteem that it is not opportune to disturb with wage demands a process of economic expansion which is benefiting their unemployed members. It is also conceivable that trade unions may accept to restrain their demands for wage increases in exchange for policies promoting employment (this is generally agreed to have happened in neo-corporatist economies). But it is also conceivable that, without relevant variations in unemployment, a change of the political climate may cause sharp increases of wage demands (as in the 1968 French May or in the Italian 1969 so-called Hot Autumn where, with nearly the same unemployment as in earlier years but with a mounting student political activity, several important worker categories obtained wage increases around 30%) – or decreases, if e.g. there is a change of government in a direction clearly hostile to the labour movement (Pinochet's Chile).

III.5. The thesis of a spontaneous tendency to the NAIRU needs anyway again the so-called 'Keynes effect': a level of output higher than the NAIRU level causes – it is argued – an acceleration of inflation (due to money wage increases) which increases the demand for money and the rate of interest, so investment decreases, and unemployment returns to the NAIRU level. Without the spontaneous tendency to the NAIRU which the Keynes effect should ensure, the thesis that the long-run growth trend is determined by the NAIRU becomes even less credible, because it needs that it be *government intervention* to ensure the tendency to the NAIRU, and

this is hardly credible, in view e.g. of the long historical periods when a concern with unemployment as a regulator of inflation was not present among policy makers.

It must be concluded therefore that, if the 'Keynes effect' is judged implausible, the mainstream approach to long-run output growth loses all credibility, because it loses the mechanism which should ensure Say's Law – the adaptation of investment to the level of savings forthcoming from the income associated with the full or NAIRU level of resource utilization([19]).

Let us then turn to a discussion of the plausibility of the 'Keynes effect'.

Part IV.
Against Say's Law

IV.1. The 'Keynes effect' needs: (a) that changes in money wages influence the price level in the same direction; (b) that changes in the volume of monetary transactions change the demand for money; (c) that changes in the demand for money alter the rate of interest; (d) that changes in the rate of interest alter aggregate investment in the opposite direction.

I have already argued that (a) is highly debatable (§III.4). It is well known that doubts have been advanced on (c) on the basis of 'endogenous money' arguments of various types([20]). Here I shall limit myself to discussing (d) i.e. the thesis that aggregate investment depends negatively on the rate of interest.

IV.2. Why investment should be a negatively elastic function of the interest rate is something on which there is at present considerable disagreement; and more and more economists are skeptical about the whole idea.

It is well known that the *empirical* evidence is unable convincingly to support the thesis that the rate of interest exerts a significant influence on investment. This conclusion of older

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[19] . There is general consensus (cf. e.g. Patinkin, 1987) that the real-balance effect is too weak, and too fraught with difficulties caused by the required price decreases (e.g. bankruptcies), to be relied upon as a plausible mechanism ensuring a sufficiently fast tendency of aggregate demand to increase when prices decrease. A recent calculation by Sawyer (1997, Section 6) based on the NAIRU model of Layard, Jackman and Nickell concludes that a decrease of the fiscal stance causing a 1% decrease of aggregate demand would require a 67% decrease of money prices in order for the real balance effect to counterbalance it − assuming no perverse effects of the price decrease on investment.

[20] . Besides the well-known modern defenders of the endogeneity of the money supply owing to overdraft facilities or the creation of money substitutes, such as Kaldor or Basil Moore, it is interesting to remember that recently David Romer (2000) has proposed to give up the LM curve of the IS-LM model owing to the observation that central banks increasingly target the interest rate rather than the money supply. Pivetti (1991, Ch. 2) summarises evidence suggesting that this is not only a recent tendency as Romer suggests, but a nearly universal aspect of capitalism in industrialised countries.

empirical inquiries (cf. e.g. Junankar, 1972) has not been disproved by later econometric research. The recent survey of investment theory in the *Journal of Economic Literature* concludes:

> "While there is clearly no uniformity in the results and the role of shocks remains to be assessed, it appears to this author that, on balance, the response of investment to price variables tends to be small and unimportant relative to quantity variables." (Chirinko, 1993, p. 1906; also see *ibid*., pp. 1881, 1883, 1897, 1899)

Thus the empirical evidence would appear to suggest that the negative influence of the rate of interest on aggregate investment, if it exists at all, is too weak to justify the belief that investment adjusts to savings faster than does savings to investment via the Keynesian mechanism of variations of aggregate income. Edmond Malinvaud (1995, pp. 125-7) comes to the same conclusion([21]).

This conclusion ceases to be surprising when one realises that there is no solid *theoretical* justification either, for the thesis of a negative elasticity of investment vis-à-vis the interest rate. Nor am I arguing here anything particularly new: the decisive criticisms of the several attempts to justify this thesis have all been around for a considerable time; so the continuing dominance of this thesis can perhaps be explained (apart from its fundamental role in the whole of mainstream macroeconomics([22])) through the absence so far of a simultaneous criticism of all these theories, so that when one of them is criticised, people believe they can still turn to one or more of the other ones.

The traditional support for that thesis was the belief in capital-labour substitution, with capital treated as a homogeneous factor, an amount of value. The untenability, admitted by both sides in the Cambridge controversies on capital theory, of that conception of capital undermines that support (Garegnani, 1978, 1990; Petri, 1997).

Nor are the attempts to defend that thesis on a basis independent of that conception of capital any more solid. For reasons of space I shall be very brief (a more extended discussion is in Petri, 1997). One can distinguish the following main arguments:

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[21] . Also cf. Hall (1993, p. ???): "established models are unhelpful in understanding this [1990-91] recession, and probably most of its predecessors....In spite of low interest rates, firms cut all forms of investment....Little of this falls into the type of behavior predicted by neoclassical models."

[22] . In an advanced macroeconomics textbook of some years ago one could read that the adjustment cost approach was "the most successful attempt to rationalize the Keynesian investment schedule" (Sargent, 1979, p. 127), with this sentence being followed by no discussion at all of *how* successful (perhaps not very?), the assumptions of the approach being listed without any mention of the criticisms advanced against them − as if it were anathema to contemplate the possibility that the "Keynesian investment schedule" (i.e. the thesis of a negative dependence of investment on the interest rate) might have to be rejected.

(a) 'array of opportunities'
(b) liquidity constraints
(c) adjustment costs
(d) Jorgenson
(e) Tobin's *q*.

All of them either must ultimately rely on the conception of capital as a single factor, or suffer from other decisive deficiencies.

IV.3. Gardner Ackley (1978) uses the term 'array of opportunities' for the theory (presented e.g. in Samuelson's textbook, cf. Samuelson-Nordhaus (1985, Ch. 7)) that entrepreneurs have at each moment of time in front of them a series of investment projects, which they rank in order of decreasing internal rate of return; they then adopt all the projects with a rate of return not lower than the rate of interest; so a lower rate of interest means the adoption of more projects, hence a greater aggregate investment. The basic weakness of this approach is that it treats the returns from the investment projects as given independently of the rate of interest, as if prices could be treated as given. On the contrary, value theory argues that competitive prices tend to equal costs of production; so if the rate of interest decreases, prices will tend to decrease too (relative to money wages) because interest is one of the costs, so the rates of return will tend to decrease as well; furthermore, the tendency of investment to go in greater proportion toward the employments where the rate of return is greater will also tend to annul the differences in rates of return. So for the analysis of long-period decisions such as investment decisions, one must admit that the rates of return move with the rate of interest and are, on average, equal to the rate of interest (plus an opportune risk allowance, of course). By the way, this was fully admitted by the traditional marginalist approach, which argued that a decrease in the interest rate would increase investment, not by increasing the difference between rate of return and rate of interest, but by altering the optimal capital-labour proportions in the several industries, when prices had adjusted so as to render again the rate of return equal to the rate of interest. And Ackley in fact harshly criticises the 'array-of-opportunities' approach and concludes that the reason, why a decrease in the interest rate increases investment, must lie in the inducement to "*deepening*", i.e. to an increase of the capital-labour ratio:

> the original classical basis for the declining investment schedule....clearly lies in consideration of aggregate "factor proportions" for the entire economy (*ibid.*, p. 625, footnote 15)([23]).

[23]. Ackley, like Keynes, uses "classical" to mean essentially pre-Keynesian marginalist economics.

Unfortunately for this approach, we now know that there is no guarantee that a decrease of the interest rate will create an inducement to "deepening": the results of the Cambridge controversy show that the capital-labour ratio can change either way, thus undermining "the original classical basis for the declining investment schedule".

IV.4. Another derivation of a decreasing investment function, making no reference to the 'capital' intensity of production, relies on Kalecki's "principle of increasing risk" (and more recently e.g. with Fazzari has come to be called the liquidity approach). Kalecki (1937) argued that the marginal efficiency of investment (the rate of return over an additional unit of investment) for a single firm should be taken to be not decreasing, but rather constant, in competitive conditions: since the competitive firm treats prices (of inputs as well as of outputs) as given and decreasing returns to scale are not plausible, then, were it not for the increasing risk, if even only one investment project had a marginal efficiency greater than the rate of interest the firm would plan to replicate it indefinite times, i.e. would plan an infinite amount of investment; but in order to invest more, a firm must increase its debt/asset ratio (given that normally a part of investment comes from internal funds, so not all assets are matched by a corresponding debt), thus increasing its risk of default and bankruptcy, and the rising "cost curve" of borrowing, resulting from the addition, to the rate of interest on safe loans, of the rising risk allowance, renders investment determinate. This approach is often used to argue a dependence of investment on sales or cash flow i.e. on demand, but here we are interested in the implication (not much stressed – but admitted – by Kalecki) that a decrease in the basic rate of interest will shift the "cost curve" of borrowing downwards, and thus induce price-taking firms to adopt a higher debt/asset ratio, i.e. to borrow more and invest more. A basic weakness of this approach is that, again, prices and costs other than the cost of borrowing, and hence the expected rate of return on investment (the expected rate of profits), are considered independent of the cost of borrowing. If it is accepted that autonomous variations in the real interest rate will result in variations in the same direction of the rate of return via variations of the price level relative to money wages, then a variation of the interest rate will *not* cause a persistent variation in the opposite direction of the difference between interest rate and profit rate, and therefore will not create any (non-transitory) incentive to investment. Therefore the debt/asset ratio might well be an important determinant of the investment of some firms, and perhaps even of the entire economy; but it is not legitimate to derive from it an investment schedule negatively elastic with respect to the interest rate.

IV.5. The adjustment costs approach (Eisner and Strotz (1963); see Söderstrom (1976), Galeotti (1984), Abel (1990) for surveys of the subsequent vast literature) argues that if the optimal capital stock *of a firm* exceeds its actual capital stock but there are increasing marginal costs to expansion (a more rapid adjustment is proportionately more costly than a slower

adjustment) e.g. because of installation or break-in costs, then the firm will not find it convenient to adjust immediately to the new optimal capital stock and will prefer to spread out its adjustment over time, choosing an optimal adjustment path.

To start with, doubts have been advanced as to the empirical relevance of the assumption that there are generalized positive adjustment costs which not only increase, but also increase at an increasing rate, with the level of investment([24]). But even leaving these doubts aside, there remain grave theoretical problems.

The approach shares with the 'array-of-opportunities' approach and with the liquidity approach the assumption that prices and costs other than the cost of borrowing are given, so that, were it not for the increasing adjustment costs, when a decrease of the interest rate creates extraprofits firms would like to become infinitely large. This assumption is made to look less criticisable by the concentration of the analysis on a single firm, but obviously it falls under the same criticism as for the other approaches the moment the object of the analysis is to determine aggregate investment (or even only industry investment, in fact).

The approach suffers from a further fundamental shortcoming: the analysis attempts to determine the optimal adjustment path of *an individual firm;* the passage to the *aggregate* investment function is obtained by assuming "that the macro function is simply a 'blown-up' version of the micro function" (Junankar 1972, p. 61; also see *ibid.* p. 43); but this aggregation procedure forgets about *possible variations in the number of firms.* The assumption that investment cannot comprise the setting up of new firms would clearly be illegitimate: reality does show the setting up of new firms. But then one must admit that the positive extraprofits which stimulate existing firms to grow should also stimulate the setting up of new firms. Then the growth rate of the *aggregate* capital stock also depends on the rate of creation of new firms, but the theory has nothing to say about it. This is admitted e.g. by Söderstrom (1976, p. 386), who writes that in adjustment-cost theories of investment "market equilibrium ....may be indeterminate under free entry": where rigour would require replacing "may be" with "is".

IV.6. Jorgenson's approach appears to have fallen out of favour recently, but it deserves at least a brief comment. Jorgenson (1967)([25]) assumes a given number of firms, decreasing

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[24] . For more on these doubts, see e.g. Nickell, 1978, pp. 37-39.

[25] . Jorgenson (1963) is very different: the rate of interest determines the desired K/L ratio and hence determines the desired K, *given the output to be produced.* The desired K is then reached with a (distributed) lag which is left unexplained theoretically and simply estimated econometrically. The analysis is formulated for a single firm with constant returns to scale, but, because of its dependence on a given output level, it can easily be re-interpreted as applying to industries, or to the entire economy: in the latter version, it has found its way in simplified form in some macro textbooks, e.g. Dornbusch and Fischer. It is then a neoclassical variation on the flexible accelerator. It is openly based on the notion of 'capital'-labour substitution and therefore falls under the Cambridge criticisms.

returns to scale, and given prices and costs other than borrowing costs. Now it is the decreasing returns to scale which set a limit to size when, the product price and other costs having remained unchanged, the rate of interest decreases. So his analysis is subject to the same criticisms as the adjustment costs approach (given number of firms, no effect of competition on profit margins), plus some more deriving from the highly debatable assumptions used to determine the speed with which the firms want to reach the new optimal dimension (e.g. it is assumed that the optimal size changes continuously and that at the initial moment the firm's size was optimal).

Thus, even from the perspective of the marginalist approach to value, Jorgenson's 1967 theory appears totally indefensible (and is so judged e.g. by Tobin in his Commentary on Jorgenson's article in the same volume).

IV.7. Tobin's *q* approach (Tobin, 1969, 1980, 1982; Tobin and Brainard, 1977) is now very popular so I need not remember what it consists of and can be again very brief. The derivation, from this approach, of a negative dependence of aggregate investment on the rate of interest rests either on adjustment costs, what has been argued to be unacceptable, or on the increasing-supply-price approach of Keynes and Abba Lerner([26]), which is empirically more than doubtful, and anyway needs the traditional notion of capital-labour substitution undermined by the Cambridge criticism in order to explain why a lower interest rate makes the aggregate of firms desire an increase of the capital stock. The increasing-supply-price approach argues that the speed with which firms will adapt their capital stock to the optimal capital-labour ratio is limited by the short-period given productive capacity of the capital-goods industries, what causes a rising supply price of capital goods as investment increases, and induces firms to limit investment rather than aim at a nearly instantaneous adjustment. The role of traditional capital-labour substitution is therefore central to the theory, and the Cambridge critique is accordingly decisive; furthermore, without an assumption of full

[26] . Tobin's original addition to the Keynesian approach to investment appears to consist in the suggestion that the stock market valuation of firms may, with caution, be used to infer the current evaluation of the present value of expected future returns. But it seems not to have been generally noticed that Tobin's *q* will also reflect - if stock markets reflect 'fundamentals' - the degree of utilization of capacity: if, on average, capacity utilization decreases below normal and is expected to remain below normal for some not inconsiderable time, then even if the interest rate has remained unaltered the capitalized flow of returns will be less than the replacement value of existing plants: it will approximately equal the value of the smaller plants necessary to produce the current output at a normal rate of utilization. An empirical finding of a positive correlation between Tobin's *q* and aggregate investment would therefore be no proof that the rate of interest has a negative influence on aggregate investment: it might simply reflect the influence on investment of the average degree of utilization of capacity, i.e. of demand. Anyway it is well known that Tobin's *q* does not perform very well econometrically.

employment of labour (at least on average over the cycle) the theory becomes indeterminate because a given capital-labour ratio does not determine the desired capital stock unless labour employment is given([27]).

IV.8. One may conclude that the more recent justifications of the view of aggregate investment as a decreasing function of the interest rate either ultimately rely on the indefensible traditional marginalist conception of capital as a single factor, or are theoretically indefensible even apart from the criticisms of marginalist/neoclassical capital theory, or both. In particular, again and again the mistake recurs, of treating the yields from investment projects as independent of the level of the interest rate, a mistake pointed out also by the more attentive mainstream theorists, e.g. by Ackley (1978) and even by Jorgenson (1967, p. 152, quoting Alchian (1955)).

Thus at present there is no defensible theoretical justification of the standard view of investment as a regularly decreasing function of the interest rate.

That a significant negative elasticity of investment with respect to the interest rate may not be easy to confirm empirically is then no longer a puzzle: there simply is no theoretical reason why it should be observed([28]).

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[27] . This is a problem already in Keynes, and much of the confusions and uncertainties of subsequent investment theory would appear to derive from a desire to stick to the traditional approach to the demand for capital when its foundation in the full employment of labour had been abandoned with Keynes or with the IS-LM model.

[28] . That some negative influence of the interest rate on investment may be sometimes detected by empirical studies does not anyway appear surprising to the non-neoclassical theorist. There are several non-neoclassical indirect routes through which such an influence might operate; but their working is not guaranteed, and there are also routes through which the influence might be of opposite sign, so that no general and unambiguous conclusion, independent of the specificities of the situation, appears derivable. E.g. a lower interest rate in a single nation may cause outflows of financial capitals which cause a devaluation which stimulates exports and thus, through the accelerator, stimulates investment; or, with a fixed exchange rate, the lower interest rate, by decreasing production costs in that nation relative to other nations (just like a decrease in real wages), may lower the price level or slow down its rate of increase and thus increase the nation's competitiveness and again stimulate exports and thus investment; on the other side, the lower-than-abroad rate of return on investment, associated with the lower product prices, or higher import prices, may well for some time discourage, rather than encourage, investment (Chirinko, in the quoted survey of investment theory, cites econometric evidence giving some support to the thesis that a higher rate of return on capital has a positive influence on investment, i.e. that a lower rate of return, such as will be presumably associated with a lower rate of interest, has a negative influence on investment). Or the lower interest rate, by being associated with a redistribution of income away from property incomes toward labour incomes, may induce an increase in the average propensity to consume, and thus in the multiplier, and thus again stimulate investment through the accelerator; on the other side, the increase in consumption may induce the business

IV.9. Nor can any help for mainstream macroeconomics be derived from modern general equilibrium theory. The latter, as is increasingly recognised, is barren of implications for the behaviour of actual economies, where adjustments take time and can therefore cause phenomena (e.g. multiplier-accelerator interactions) which cannot be admitted in the study of the stability of general equilibrium models in their modern formulations – formulations which, owing to the inclusion, among the data of equilibrium, of a given vector of extremely variable quantities such as the endowments of the several capital goods, cannot admit time-consuming disequilibria with production going on during the adjustments (Petri, 1999). Furthermore, it is well known that even the stability of the sole admissible, fairy-tale adjustments is generally not guaranteed, and this has induced some general equilibrium specialists, e.g. Kirman, to look for different approaches.

IV.10. There is therefore no theoretical basis for viewing the interest rate as the price bringing investment into equality with savings. Say's Law – the thesis that investment adapts to savings – loses its foundation. The faith in the spontaneous tendency of market economies to the full employment of resources must therefore be abandoned, because there can be no presumption that aggregate demand will spontaneously rise to equal full-employment output.

It is then natural to turn again to the principle of effective demand, i.e. to the thesis that it is variations in income which bring about the equality between savings and investment or more generally between aggregate income and aggregate demand. Then output and its growth must be explained through the evolution of the autonomous components of aggregate demand. The reconciliation will finally be easier between economic theory and historical episodes such as the Great Crisis of the 1930s, or the persisting European unemployment. And the theory of *per capita* growth will have to recast its insights accordingly.

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community to expect restrictive government policies because of balance-of-payment constraints or fears of inflation, and thus it may discourage investment.

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