

**Technical change, effective demand
and employment**

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"...it seems to me that we should not make use of the concept of autonomous investment at all", Duesenberry (1956, p.141)

1. Introduction¹

The relation between innovation and employment is of particular interest today. For instance, the recent rate of job creation in most European countries has been rather poor and unemployment has reached in the last fifteen years or so levels unknown in the preceding post-war period. Could technological change be the cause of these high unemployment levels? This is a traditional thesis recently recovered by popular authors (Rifkin, 1995), but also echoed, with more sophisticated arguments, by mainstream economists to justify the dismantling of post-war II labour and social institutions, allegedly to cope with structural change. The position of mainstream economists seems reinforced by the case of the US in which, according to their opinion, the association of a more “flexible” labour market and strong technical change is behind the better employment performance.

The purpose of this paper is to present a critical examination of the theoretical relationship between technical change and aggregate employment. This relationship is treated in different and, sometimes, in opposite ways by different theories of distribution and accumulation. The analytical strength of some of these positions is assessed here. According to *Neoclassical economists* technical change is always beneficial to labour employment, provided that factor markets can work freely and competitively. This view is the most influential nowadays, but it is not free of serious theoretical and empirical shortcomings. This approach is contrasted to the renewed strength that the work of Sraffa and the results of the capital theory controversy have given to the old *Ricardian view* of innovations as harmful to labour employment. Next, we ask

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ourselves whether 'compensation mechanisms' to technological unemployment could be envisaged on the effective demand side. What may be called the *neo-Schumpeterian approach* suggests a positive association between technical change and effective demand. In this case a compensation effect would be due to the positive effects of innovations on autonomous investment. This view is discussed and criticised by using a simple supermultiplier model in which effective demand is the determinant of economic growth. Our general conclusion is that there are no basis to believe that there will be sufficient automatic compensation effects either of the Neoclassical or neo-Schumpeterian types. Fast technical change and full employment are only consistent either by circumstances that somehow affect effective demand - such as exports or speculative bubbles that affect consumption patterns – or, more preferably and systematically, through the adoption of expansionary macroeconomic policies.

2. Technical change and unemployment in neoclassical theory and in Ricardo

2.1. *The Marginalist or 'mainstream' view*

According to the marginalist approach market economies, if left free to operate, i.e. if prices are flexible and there are no obstacles to competition, always tend to the full employment of labour, and do so also when technical change reduces the labour inputs required to produce a given output.

Such tendency to full employment is brought about by the substitutability between factors of production, which in turn relies on two mechanisms. The first, *direct* substitution, is the change in the proportion in which the factors of production are used in the production process. According to the theory, the additional employment of one unit of a productive factor (say, labour), given the amount of the other factors, has decreasing returns (the marginal product of labour is decreasing). Accordingly, if for example, there is a shift in labour supply caused by immigration, or some other demographic phenomena, and the price of labour falls as the additional labourers compete for employment, entrepreneurs will find it more profitable to use techniques that involve a higher proportion of labour in combination with the other fully employed factors, up to the point at which the marginal product of labour equals the new full employment wage level. If there are no constraints preventing the required fall in wages this process will lead towards the full utilisation of the additional labour supply, albeit at a lower real wage, and to a growth of national output.

The second, *indirect* substitution mechanism works through changes in consumers' optimal choice of their consumption baskets as the relative prices of factors and goods change.

Again, let us suppose an increase in labour supply and fall in the real wage. According to the theory, this brings about a fall in the relative prices of the goods that are produced with labour-intensive techniques (i.e. techniques entailing a higher proportion of labour to the other inputs). This fall tends to alter consumers' demand in such a way that the (now supposedly cheaper) labour intensive commodities will be demanded and produced in a higher proportion than they were before, thereby increasing the demand for labour in the economy. Thus, even if there is no factor substitution in production (i.e. the 'production function' has fixed coefficients), the economy will tend to full employment.

In this analytical framework innovation has in one respect the same effect as an increase in the quantity of production factors, say labour and capital:² as these tend to be always fully employed, such an increase will necessarily result in an increase in the level of production and income 'as soon as the liberated resources can be effectively transferred to new uses' (Hicks, 1932, p.121).

As well known, according to the seminal Hicksian analysis, an innovation is most likely to raise the full-employment marginal productivity of all 'factors', labour and 'capital'. An innovation is said 'labour saving' if the full employment marginal productivity of labour increases proportionally less than that of the other factor, suggesting that the innovation has made labour relatively less scarce. Only in the case of 'very labour-saving' innovations will the full employment marginal productivity of labour and the equilibrium real wage fall.³ In this case, if the downward adjustment of the real wage is not immediate the innovation may initially create some unemployment. The competition among workers, however, will induce the fall in the real wage and the inception of the two mechanisms illustrated above.⁴ Thus, according to the traditional neoclassical framework technical change may cause *temporary* unemployment if technical change is very labour saving and the adjustment to the new lower equilibrium wage is

² In another respect the outcome is quite different, as innovations may well increase the equilibrium marginal product, hence the returns, of all factors of production, while the increase in the quantity available of one factor (given the others) will certainly diminish its own equilibrium marginal product.

³ Hicks, 1932, pp.121-122. To understand the nature of very labour saving techniques one can refer to the usual labour demand and supply diagram. A very labour saving innovation will cause an upward shift of the intercept of the labour demand schedule, but at a same time a change in its slope such that it now intersects the supply schedule below the previous equilibrium real wage.

⁴ If the labour supply curve is elastic, the new full employment equilibrium may be characterised by a lower employment level (cf. Kliman, 1997).

not immediate. Note, however, that Hicks regarded very labour saving innovations as an extreme case that would seldom occur (or rarely occur so pervasively to outweigh the positive effects on the equilibrium wage rate deriving from other types of innovations).

If the technical innovation occurs in a single industry and the elasticity of demand for the product of this industry is not high enough to allow the same employment level in that industry, part of the labour force will have to move to other industries and this may create frictional unemployment

However, while contemporary mainstream theory retains the mechanisms described above, and envisages an underlying tendency of market economies to full employment, in applied analyses it is generally maintained that not only temporary, but also persistent unemployment may result from innovations. Consistently with the general approach outlined above this is attributed to market imperfection and price rigidities, and particularly of institutional factors, such as the existence of unions, unemployment benefits, costly firing procedures and the like. These rigidities would tend to prevent the required adjustments both in the level and in the relative values of real wages and the necessary mobility of the labour force between industries and occupations with the consequence of preventing the working of the substitution mechanisms just described, and of rendering rather persistent the unemployment resulting from innovation and structural change. Thus, while it is maintained that innovation and structural change will not cause long run unemployment if markets work freely and competitively, in the actual situation of contemporary industrial countries, and particularly in Europe, high and persistent unemployment is often said to be associated to technical and structural change, as a consequence of the existence of 'rigidities' in these economies which prevent the required adjustments.⁵

To enquiry further in what ways technical change may cause persistent unemployment in the mainstream framework of analysis we must turn to the conventional explanation of persistent unemployment based on the concepts of the natural unemployment rate and of the NAIRU - non accelerating inflation unemployment rate. While an entirely clear-cut distinction between the two concepts cannot be drawn, the first is usually regarded as associated mainly with frictional (mismatch) and voluntary search unemployment, while the second is generally

⁵ This is for example the diagnosis provided by the Oecd's *Jobs Study* :

'After having considered the available evidence and the various theories which have been advanced to explain today's unemployment, the basic conclusion was reached that it is *an inability of Oecd economies and societies to adapt rapidly and innovatively to a world of rapid structural change that is the principal cause of high and persistent unemployment*' (Oecd, 1994, p.vii, italics added).

used to indicate an equilibrium unemployment which includes, besides the above two components, involuntary unemployment resulting from various market or information imperfections leading to equilibrium wages higher than full employment wages (particularly resulting from efficiency wages, union bargaining, and hiring and firing costs).

The fact that in any economic system 'shocks' - i.e. structural changes, including technical innovations - are continuously occurring, is regarded as at the root of the two major components of the natural unemployment rate:

i) *Mismatch between labour supply and demand*: 'shocks' will tend to determine a difference between the characteristics (skills, education etc.) of the labour supply and those required by the employers.

ii) *Voluntary search unemployment*: the 'shocks' also alter equilibrium relative prices and wages. Since economic agents incur costs and take time to acquire information about them, for each occupation there will not be a single wage offered by firms, but a distribution of wages. This, it is argued, renders rational for workers to spend some time collecting information and searching for the best opportunities while remaining unemployed (Phelps *et al.*, 1970). This type of unemployment, other things constant, would be increased by an *intensification* of the 'shocks' - hence by an intensification of technical change - because this would increase the wage dispersion around any given mean and this in turn increases, according to the model, the reservation wage and the duration of search on the part of the 'optimising' unemployed.⁶

In addition, according to the literature concerning the NAIRU, equilibrium can be associated to involuntary unemployment due to:

iii) *obstacles to free competition and market imperfections*. Technical change may also raise the natural unemployment rate that results from these factors, particularly as they are analysed in 'Insiders-outsiders' models. These have pointed to the ability of employed workers (the 'insiders') and their unions to fix wages at a level higher than that compatible with full employment. This ability is said to derive from the bargaining advantage due to the existence of hiring and firing costs, which are to an extent determined by institutional factors (for example, the existence of costly firing procedures). The insiders' objective (according to this view) is to obtain the maximum wage compatible with preserving their employment. Hence, the marginal

⁶ The conclusions from search models in this respect are at odds with the data, which show that higher unemployment in Oecd countries is associated to periods of less intense structural change.

product of labour at the given employment level fixes a maximum to the real wage. If an initial 'shock', which may be caused by a very labour saving innovation, diminishes employment in some firms, the remaining 'insiders' in these firms will tend to fix the wage at the new higher level compatible with the lower employment. Even if the innovation is *not* very labour saving but there are, as assumed in some insider-outsider models, asymmetries in the response to 'shocks', unemployment can result. This will occur if in the firms where the innovations shifts to the right the labour demand schedule there will only occur a rise in the wage level at a constant employment level, while in the firms where the innovation has a negative impact (for example because they have not innovated and lost market shares) there will not be any change in wages while employment will fall. Once it has so diminished, the mechanism of wage determination in these models prevents competitive pressure towards wage adjustment from the unemployed outsiders (Lindbeck and Snower, 1986; 1988).

To sum up, according to the mainstream interpretation, innovation and structural change (or their intensification) may - other things constant - increase the 'natural' or equilibrium unemployment determined by mismatch, 'search', and market imperfections. Consistently with this analytical background, it is suggested that attention should be focussed on flexibility and individual incentives to adjust rapidly to a changing environment in order to create an institutional framework favourable to mobility.

2.2. *Technological unemployment in Ricardo*

At the beginning of the last century, David Ricardo initially maintained the opinion, similar to that illustrated above, that the 'application of machinery to any branch of production' is 'a general good, accompanied only with that portion of inconvenience which in most cases attends the removal of capital and labour from one employment to another' (1951, p.386). This opinion is based on the idea that an *equal* amount of labour employed with the newly invented machinery will give rise to a greater real income, beneficial to all social classes. But subsequently Ricardo came to the different conclusion that 'the discovery and use of machinery' can be 'injurious to the labouring class' (1951, p.390). To follow the reasoning behind this last proposition consider the following relations:

$$(I-A)X = \underline{Y}$$

Where A is the matrix of the production inputs for unit of output; X is the vector of the social product; \underline{Y} is the *given* vector of output net of the circulating capital used up in production. The labour requirement, hence the employment level associated to the given \underline{Y} , will be given by:

$$L = l X = l (I-A)^{-1} \underline{Y}$$

Where l is the vector of labour requirements per unit of output.

According to Ricardo the introduction of machinery would reduce terms in l and A , hence cause a fall in the employment level.⁷ Observe that in Ricardo we do not find the idea that wage flexibility can lead to 'factor substitution' and full employment, the mechanism later envisaged by neoclassical economists, and this in turn is at the root of the assumption of a given vector of output.⁸

The interest and the force of the 'Ricardian case' has been renewed by the recovery of the Classical approach by Sraffa, who highlighted the distinctive analytical structure of the classical approach. It is the absence of substitution mechanisms that explains the possibility of persistent unemployment in the Ricardian framework (for a formal demonstration of this proposition see Montani, 1985). Failure to perceive this crucial difference has often led to misinterpretations of the 'Ricardian effect' as a 'transitory' or 'short run' phenomenon occurring in the transition towards a new, full employment equilibrium and to associate it to particular assumptions concerning the nature of technical progress (Wicksell, 1981 [1924], Schumpeter, 1954; Katsoulacos, 1986).

Sraffa not only suggested that the neoclassical substitution mechanisms were absent in the classical approach, but he also demonstrated that they are logically flawed. This inspired in the 1960s the controversy on the neoclassical notion of 'capital' (for an overview see Harcourt, 1972; for more recent discussions see Eatwell et al., 1990; Kurz, Salvadori, 1995, Ch. 14, Garegnani, 2000 and Schefold, 2000).

⁷ Ricardo assumed that the machinery would not be subject to wear and tear. Removing this simplifying assumption would lead to consider also a matrix of amortization quotas of existing fixed capitals, some of which might be increased by the innovation. There would be no *a priori* reason however to expect that this would compensate for the fall in direct labour requirements and circulating capital conceived by Ricardo. More in general, it is possible to conceive innovations that would allow an increase in the rate of profit for given values of the real wage while at the same time increasing labour requirements for a given vector of net output (in terms of the wage-profit curve these would be innovations that shift towards the origin the intercept on the real wage axis and outwards that on the profit rate axis).

⁸ Ricardo, that shared Say's law, conceded that the negative effect of the innovation on employment *might* be *gradually* and *partially* offset if the capitalists invested their higher real incomes, thus enlarging productive capacity and employment.

Put simply, this controversy pointed to the peculiar nature of 'capital', which is not an 'original' factor measurable in some conventional unit, as is the case for labour or land, but it is a produced commodity measurable only in 'value'. This has important consequences for the reliability of the two neoclassical substitution mechanisms described above.

The first substitution mechanism - *direct substitution* in production - predicts that when, for example, the wage rate falls, methods of production using more labour relative to the other inputs will become more profitable and the demand for labour will rise. Sraffa (1960) and other contributors to the capital controversy of the 60s have shown that this is not the general case, and that when there are a multiplicity of techniques and 'heterogeneous' capital goods (that is many kinds of capital goods), the so-called 're-switching of techniques' makes the neoclassical prediction unreliable. This is because as distribution varies the relative prices of the produced capital goods used directly and indirectly in the production of any commodity will change. Thus it may happen that a technique - using directly and indirectly a certain amount of labour per unit of net output - is the most profitable (least costly) for low levels of the real wage rate as well as for high levels of it, while a different technique is the most profitable at 'intermediate' levels of the wage rate (Sraffa, 1960; Garegnani, 1970). Hence a monotonic inverse relation between the real wage and labour demand cannot be demonstrated.

The second mechanism, *indirect substitution* through changes in consumption patterns, requires a) that as, for example, the wage rate declines, the relative price of the labour-intensive goods falls; b) that this is followed by a larger consumption of the relatively cheapest goods. Now the first step is put in doubt again by the conclusions of the Capital theory controversy. It has been shown (Sraffa, 1960) that as the wage rate varies from maximum to zero, the price of any commodity A may alternately fall and rise relative to the price of another commodity B, so that no *a priori* expectations as to the direction of the change, based on the 'factor intensity' in the production of the two commodities, is justified. ⁹

⁹On the other hand it cannot be claimed that the inverse relation between the real wage and employment, despite a lack of sound theoretical foundations for the reasons just discussed, has nevertheless on its side striking empirical support (see Zenezini, 1993 for a discussion of the issue). Work by Anyadike-Danes and Godley (1989) shows that the relation between real wage and employment apparently found in econometric models may be spurious; research on real wages over the cycle does not support the inverse relation (Michie, ??); recent empirical research showing that the introduction or the increase of minimum wages (Card, Krueger 1996) does not negatively affect employment can also be regarded as signalling the lack of empirical support for the inverse relation.

To those trained in neoclassical economics, the 'Ricardian approach' may at first sight appear as too primitive and missing important aspects of consumers' and entrepreneurs' behaviour. We have shown, however, that neoclassical substitution mechanisms require assumptions concerning the direction of the substitution taking place when relative prices and distribution change, which are undermined by theoretical results.

The modern non-conventional theory confirms Ricardo's opinion that there are no *necessary* compensation effects to technological unemployment. But is then, according to the non-conventional view, technological unemployment an irreversible result? To answer this question we must turn to the demand side. While the role of compensation effects on the demand side is ruled out in principle by neoclassical theory (since in this view substitution mechanisms always lead the system towards the level and composition of output that ensures the maximum possible utilisation of all the existing resources), the Ricardian approach is not *necessarily* associated to the acceptance of Say's Law, and once this is rejected, the analysis is open to the investigation of the compensation effects and policy prescriptions on the demand side.

3. Technical change, investment and Effective Demand

The idea that technical change affects the demand for of gross investment in the long run is taken for granted by most of the economists of otherwise different persuasions. The association between innovation and gross investment has traditionally been considered one of Schumpeter's main lessons. Mainstream economists have seen this view as consistent with neoclassical theory. This claim is not without foundations, as we will briefly argue. By contrast, some modern heterodox followers of Schumpeter have advanced the idea of a complementarity between Schumpeter's explanation of investment and Keynes' theory of Effective Demand. We shall examine critically this second claim.

3.1. *Technical progress and investment : neoclassical and Schumpeterian views*

According to the marginalist principles, technical change normally shifts the marginal productivity of capital schedule to the right. In flow terms, the gross investment function, derived from the demand of capital schedule, also shifts to the right. In general the long period real interest (profit) rate will rise. How much depends on the behaviour of the full employment saving supply schedule, whose slope and position hinges on, respectively, the elasticity of full employment saving with respect to the interest rate and to income. Observe that the positive effect of technical progress on gross investment must not be interpreted as a relaxation of the marginalist view that sees full employment saving as the determinant of aggregate investment.

In this approach the technical conditions of production along with the physical quantities of the other production factors which are being employed determine the demand for investment (capital), and technical change can increase the *demand* for investment.¹⁰ However, the *actual level* of investment (capital) depends on the position and slope of the supply of (full employment) savings.¹¹

Schumpeter did not challenge this view.¹² His focus was on the effects of innovations on the *composition* of investment, but not on the determination of their *level* and *rate* of growth, that was left to the traditional theory. For instance, Schumpeter argued that: 'the carrying into effects of an innovation involves, not primarily and increase in the existing factors of production, but the shifting of existing factors from old to new uses' (Schumpeter, 1939, p.111; 1934, p.67-8). The role of the credit system in a non-planned economy is precisely that of permitting this shifting of resources from the old to the new firms (1939, pp.111-112; 1934, p.69). Absent in Schumpeter is therefore the idea of the independence of the *level* of investment from the full employment saving supply. As a result, his view of the association between technical change and investment can be seen as complementary, stressing the *qualitative* aspects of investment, rather than alternative to the marginalist one.¹³ Indeed, Schumpeter's contribution, although relegated to the margin, has never been rejected by mainstream economists, and the process of 'creative destruction' can be identified as the process of structural change dealt with in item 2.1 above .

3.2. A marriage between Schumpeter and Keynes?

¹⁰ Note however as Wicksell and Hicks (see above section 2.1) have argued if technical change is 'very capital-saving' the marginal product of capital may actually decrease and with it the demand for gross investment.

¹¹ By contrast, according to Keynes's Principle of Effective Demand saving adjusts to the level of investment through changes in income.

¹² Nor have done the recent neoclassical Endogenous Growth Theories. For a critical discussion of these see Cesaratto (1999a, 1999b).

¹³ The nature of a *qualification* of the traditional theory of growth is apparent from the footnote that Schumpeter (1939, p.111) adds to the above quotation: 'Even with respect to those quantities of factors which currently accrue, say, in an increasing population, and can be used for the new purposes without having previously served any old ones, it is more correct to say that they are shifted from new uses they would have served had the new purposes not been decided on, than simply to say that they go to the new uses directly. The point is of some importance, because in the traditional model it was increase in factors, rather than the shifting of factors, that was made the chief vehicle of economic progress'.

Other economists working in the Schumpeterian tradition, for instance Chris Freeman and his SPRU associates (Freeman et al., 1982), or the scholars in the 'long waves' tradition (e.g. Kleinknecht, 1992, p.9), have seen the possibility of a marriage between Keynes and Schumpeter. This would lie in the idea that the *level* of investment (not only its composition) is determined by innovations.¹⁴ In this perspective, a compensation effect to the technological unemployment generated by innovations on the production side can be envisaged on the (effective) demand side. For instance Freeman argues:

Whereas in neo-classical theory the emphasis is on factor price flexibility and in keynesian theory on aggregate demand, with Schumpeter it is on *autonomous investment*, embodying new technical innovation that is the basis of economic development and new employment. In such framework economic growth must be viewed primarily as a process of reallocation of resources between industries and firms. That process necessarily leads to structural changes and disequilibrium if only because of the uneven rate of technical change between different industries and countries. Economic growth is not merely *accompanied* by fast growing new industries and the expansion of such industries; it primarily *depends* on that expansion. The new firms and new industries are an essential source of the new employment, which compensates for the loss of jobs in declining industries and firms. It is a process of 'creative destruction' in which the process of job creation outstrips that of job destruction as a result of profound structural

¹⁴ Rather than in Schumpeter, seminal work in this direction can be found in Kalecki and Dennis Robertson. The former regarded technical change as a factor that could break the tendency of capitalism towards stagnation: 'it may be said that an expanded reproduction will take place if there exist factors that simply do not permit the system to remain in the state of simple reproduction (...): the initial state of simple reproduction leads to a level of gross investment exceeding depreciation. Such a factor may be first and foremost the influence of technological innovations (...). The technical progress appears in this approach not merely as depreciating old plant, which leads to their replacement by new ones; it is also a stimulus for investment over and above that level resulting from the fact that capitalists investing "to day" think to have an advantage over those having invested "yesterday" because of technical novelties that have reached them' (Kalecki, 1971, pp.150-51). Kalecki, however, was more sceptical than Schumpeter as to the the long-run demand effects of innovations: 'The above should not be constructed in the sense that such a possibility of expanded reproduction (...) is tantamount to the elimination of influence of inadequate Effective Demand. Indeed the rate of expanded reproduction resulting from this factor is by no means necessarily adequate to secure the full utilization of equipment or even to keep the degree of this utilization at a constant level. Innovations break the impasse of a simple reproduction only to some extent and they do not warrant the utilization of resources (...)' (ibid, p.151). The instability of investment was linked by Robertson (1915) to waves of technical change. Interestingly, this explanation of investment led Robertson (1926), who was then working closely to Keynes, to look at investment as independent from saving and to anticipate some elements of the *General Theory*.

adjustment and not as a smooth incremental process' (Freeman, 1995, p.52, first italics added).¹⁵

We shall discuss this claim exploring the extent in which we can expect compensation effects of technical change on the various components of Effective Demand in the context of an approach to Long Period Effective Demand in the tradition of Keynes, Kalecki and Sraffa.

3.3. *The long-period theory of Effective Demand*

In the *General Theory* Keynes showed that within the limit of the full utilisation of the existing capital stock a larger amount of investment does not require a prior reduction in consumption. On the opposite, the higher level of output and income generated by the fuller utilisation of capacity would generate an amount of saving equal to the investment decisions. The 'Neoclassical synthesis' circumscribed this criticism to short-period situations of low business and financial confidence arguing that in those circumstances active fiscal and monetary policies were required to reach full employment. This was the conventional wisdom shared by the national and international institutions until, in the late sixties, the Monetarist revolution began to re-establish the pre-Keynesian doctrines as the prevailing view. Although the 'new classical economics' has subsequently receded, the currently prevailing conventional wisdom still fundamentally reflects pre-Keynesian views. Some non-orthodox economists have tried the opposite road of extending Keynes' analysis to the long period. In this approach in the long run (when the productive capacity can vary considerably) even more than in the short, investment is independent from and determines saving through increases in output. Thus the level of aggregate output is determined by the level of effective demand, defined as the aggregate expenditures forthcoming at the normal prices of production (e.g. Garegnani, 1962; Garegnani and Palumbo, 1998).

Given this aggregate output and the technology, the level of employment will also depend on the level of effective demand. Innovations will usually reduce the total labour requirements per unit of aggregate output and thus reduce the employment associated with any level of output. However, high growth rates of output could, in principle, compensate the decreasing labour requirements. This is shown by the well-known identity-equation $e = y - p$, where the

¹⁵ The Oecd editors of the journal from which this quotation is taken were ready to accept this optimistic view: 'In general, economists have taken the view that technology (...) may cause local and temporary unemployment, but it also causes demand to grow. If demand growth offsets productivity growth, and if wages are flexible downwards, then unemployment will not be a problem; within this type of approach, therefore, there is no general problem of unemployment as a result of technological change' (*STI-Review*, 1995, Introduction, p.11).

symbols indicates, in order, the growth rates of (the logs of) employment, of output and of productivity. Does innovation compensate technological unemployment by positively affecting the level and rate of growth of effective demand? The answer of the Neo-Schumpeterian economists tends to be positive. To discuss this claim, we shall sketch a simple model of accumulation to examine the persistent effects of innovation on the level and rate of growth of effective demand in the process of accumulation. Of course, even when some positive effect in this direction can be found, this will not necessarily be enough to compensate productivity growth. This will be discussed in the final part of this section.

3.4. *The components of effective demand*¹⁶

In the same way as in its short-period versions, from the point of view of the theory of long-period effective demand the components of effective demand must be split in two groups, induced and autonomous, according to whether they depend on the level of the real income generated by the firms' decision to produce. Using this criterion we must first separate induced consumption expenditures from all other expenditures. Induced consumption expenditures are that part of the wage bill that is spent by the workers on consumption goods. This is the only category of induced expenditures according to the above classification since in the aggregate the only income that is actually generated (and paid) by the firms' decisions to produce are the contractual or 'earned' incomes, i.e., wages and salaries. Profits and other incomes that are part of the surplus are 'residual' in the sense that they depend not only on the production but also on the sale of the product. Thus, from the point of view of the income generating process and the multiplier mechanism all other expenditures are autonomous. This classification is not sufficient, however, when we want to make an analysis of the trend of accumulation in which the capacity effects of investment expenditures are fully taken into account. Therefore we must now distinguish between the expenditures that do and those that do not have capacity generating effects. Thus we shall define as gross investment all purchases of produced means of production that can have capacity-generating effects in the sense that they can affect the potential supply of gross output of the economy.

That gives us three types of expenditures: induced consumption, gross investment and other 'unproductive' autonomous expenditures, or autonomous expenditures for short.

These autonomous *components* of aggregate demand, by definition do not create productive capacity, nor depend on 'earned incomes'. Autonomous expenditure thus comprises

¹⁶The taxonomy below follows Serrano (1995,1996).

all the sources of potential discretionary or autonomous injections of purchasing power in the economy. They include:

- (a) Total *government spending*, whose level is autonomously decided by Government;
- (b) Total *exports* whose level depends, *ceteris paribus*, on foreign demand (that is exports are financed by exogenous purchasing power).
- (c) Autonomous *consumption*, financed by consumers' credit and accumulated wealth (Steindl, 1982). Most of the expenditure by households on owner-occupied housing, usually classified as "residential investment" should be included here.
- (d) *Autonomous business expenditures*, including R&D and managerial expenses, that also do not lead to capacity creation. Here we include the important and relatively unexplored component of the autonomous business expenditure is the 'superfluous' business expenditure in, say, company cars, executive jets etc. Most of these latter expenditures are made by firms' owners and managers and are clearly a type of 'luxury' or 'unproductive' consumption that usually for tax reasons (or to hide the appropriation of the surplus by the managers from the stockholders) are disguised as 'production costs'. This type of discretionary unproductive expenditure clearly is not financed by the wage bill and thus should be classified as part of the autonomous components of aggregate demand (Cowling, 1981).

While, as we have seen, from the point of view of the income generating process and the multiplier all investment expenditures are necessarily also 'autonomous' or independent variables. This, of course, needs not be the case when we extend the analysis to the process of accumulation and fully take into account the feedback between the capacity and demand generating effects of investment. In this context it is better to consider all gross investment to be induced since these capacity creating expenditures depend fundamentally on the expectation about the evolution of the normal levels of effective demand over the life of the equipment and hence are subject to an accelerator or capital stock adjustment mechanism in the analysis of accumulation.

The following table summarises the proposed taxonomy:

	<i>Capacity creating</i>	<i>Non capacity creating</i>			
<i>Induced</i>	Gross Investment	<table border="1"> <tr> <td><i>Autonomous</i> spending, consumption,</td> <td>Exports, Business expenditure</td> <td>Government Autonomous</td> </tr> </table>	<i>Autonomous</i> spending, consumption,	Exports, Business expenditure	Government Autonomous
	<i>Autonomous</i> spending, consumption,	Exports, Business expenditure	Government Autonomous		
		Induced consumption			

3.5. *The output and capacity supermultipliers*

In order to classify and assess the various possible effects of technical change on Effective Demand, we have found useful to use a model of accumulation based on the *supermultiplier* (Kaldor, 1971; Serrano, 1995, 1996; Bortis, 1997) in which the evolution of the productive capacity of the economy follows the level and growth of the various autonomous components of aggregate demand *via* both multiplier and accelerator effects.

The notation we use is quite standard. Y is the current level of effective demand and output. Autonomous consumption (C_a), Government expenditure (G), autonomous business expenditure (B) and exports (X) are the autonomous components of effective demand. Induced (gross) investment is represented by I_i . Moreover, d is the replacement coefficient; the expected average rate of growth of normal effective demand over the life of investment that is being currently installed is denoted by g_e and v is the capital output coefficient. Again in standard notation M stands for imports, m and t for the marginal propensity to import and to tax respectively. The five equations that follow are a simple extension of the standard Keynesian model for the determination of the (gross) domestic product. The main difference is in equation [3]: the (gross) level of induced investment is a function, respectively, of g_e , d and v .¹⁷

$$Y=C + I_i+ B + G+X-M \quad [1]$$

¹⁷ Note that for the sake of simplicity we are here following the usual practice in Keynesian models of ignoring circulating capital entirely. By contrast the model in Serrano(1995,1996) assume production was carried out only with circulating capital, ignoring fixed capital.

$$C = C_a + c(1-t)Y \quad [2]$$

$$I_i = v(d + g_e)Y \quad [3]$$

$$M = mY \quad [4]$$

Let us put together all the autonomous components of final demand that do not create capacity and denote them as Z :

$$[5] \quad Z = C_a + B + G + X$$

and group the determinants of the aggregate marginal propensity to save s as:

$$[6] \quad s = m + (1 - c(1 - t))$$

From these equations we solve for the level of long period effective demand and output as:

$$[7] \quad Y = (Z) / (s - v(d + g_e))$$

We shall call the reciprocal of denominator of [7] (after Hicks, 1950, as the output supermultiplier.¹⁸ The above equation shows the level of effective demand as a function of the autonomous components of aggregate demand, considering investment not as an autonomous component but also as being induced by the expected trend of effective demand.

Note that the level of output described by the level of effective demand given by our output supermultiplier equation [7] (with a given g_e) does not necessarily entail the normal utilisation of already existing productive capacity.

That however does not mean, of course, that over time a continuous tendency of capacity to adjust itself to the trend of effective demand is not a work. Such adjustment will be happening over time as the capacity effects of the propensity to invest at given g_e materialise and as the expected rate of growth g_e itself is gradually revised in the light of actually realised growth performance.¹⁹

¹⁸ As must be the case in a demand-led model, we are assuming that the denominator of [5] is positive and thus that the aggregate marginal propensity to spend both in induced investment and consumption is lower than one. That implies that the given g_e is not too high in a precise sense: lower than s/v (see Serrano, 1995).

¹⁹ Note that as long as g_e is constant and thus the investment share is constant, the rate of growth of productive capacity will grow at the same rate as realised effective demand is

Indeed, in the process of accumulation (defined as the process in which long period positions such as [7] undergo changes), as the distance between actual and realised growth rates of effective demand narrows and the size and growth rate of capacity output adjusts itself to the trend of effective demand, leading to a tendency for the actual degree of capacity utilisation to go towards its normal or planned degree.

As a result, in the process of accumulation the productive capacity of the economy gravitates towards a fully adjusted supermultiplier in which the capacity follows the trend of effective demand and the degree of capacity utilisation is equal to the planned one. It is easy to see that in this process the growth rate of productive capacity will be tending to grow at the rate at which autonomous expenditures are growing, since it will not be possible with induced investment, to sustain growth (with given parameters s , v and d) without the expansion of autonomous expenditures.

Thus assuming that in the process of accumulation g_e is made endogenous and is gradually revised as a flexible accelerator process (Chenery, 1950), as long as the response of g_e to actually observed growth rates g is slow both the expected and actual rates of growth of the economy will have an endogenous tendency to converge to the rate of growth of autonomous expenditures.²⁰

That means that the productive capacity of the economy (which we will denote as Y^*) will have a moving centre of gravitation expressed by a supermultiplier equation in which the growth rate that appears in the propensity to invest is given by the growth rate of autonomous expenditures (which we denote by z). This “secular” capacity supermultiplier or “fully adjusted” supermultiplier can be described by :

$$[8] \quad Y^* = \frac{Z}{s - v(d+z)}$$

growing. Each discrepancy between g_e and the actual rate of growth of demand and output will appear as a difference between the *level* of productive capacity and the *level* of effective demand and output.

²⁰ We are assuming that the current value of g_e is revised over time according to an equation such as $g_e^t = g_e^{t-1} + x(g_e^{t-j} - g_e^{t-j})$ where t is the current period at which those expectations are formed, x is the reaction coefficient and j is the size of the time lag. If we set x and j equal to 1 we have the rigid accelerator used by Hicks(1950) which for most parameter values leads to empirically implausible instability (and the need for non-linearities to produce plausible results). We are thus assuming a “flexible” Chenery accelerator with low values for x or/and longer lags to ensure the dynamic stability of the multiplier-accelerator process.

Equation [8] describes the centre of gravitation of the process of accumulation set by the pace of the autonomous components of effective demand.²¹ Changes that affect one or more of the various elements of equation [8] can have a persistent effect on the trend of the productive capacity of the economy. Taking advantage of this result, let us look at the effects of technical change on the long period rate of accumulation through the lenses of these two supermultipliers (equations [7] and [8]).²²

3.7. The effects of technical change on long period Effective Demand

3.7.1. Autonomous or unjustified investment?

As seen above in the quotation by Freeman, there is a well-established view that argues that technical change directly affects effective demand through its effect on the levels of autonomous investment. Indeed it is common practice since Kalecki's earlier trade cycle models and Hicks's own supermultiplier to include in the same model both an induced and an autonomous component of investment and to explain the latter by reference to technical change (e.g. Gandolfo, 1996, ch.6). Behind this practice there is the idea that somehow this autonomous investment component does not create any new net capacity and thus can be simply added to the induced investment component.

This practice although still quite common has been long ago effectively by Kaldor (1951) and Duesenberry (1957). The main point is that when the innovators who are making the autonomous investments steal market shares from the non innovators it is very hard to see why the non innovators will not react to their reduced market shares and degree of capacity utilisation by contracting their own induced investment expenditures. Indeed in models in which autonomous and induced (gross) investments are simply added there the implicit assumption that

²¹ Again in order for the level and growth of capacity output be seen as being demanded, the marginal propensity to spend that appears in the denominator of the capacity supermultiplier must be lower than one. That requires that the actual rate of growth of autonomous expenditures z should be sufficiently small (see footnote 10).

²² Note that in Serrano (1995,1996) the assumption of production by circulating capital only made unnecessary the distinction between these two supermultipliers, for in a pure circulating capital economy both the adjustment of market to normal prices and output to demand on one hand and that of the capital stock to demand on the other can be thought of operating with roughly the same speed.

non innovators keep trying to provide productive capacity for the whole market even as their market share clearly and systematically does not justify that.²³

Thus it seems reasonable to think that the accelerator or capital stock adjustment process will tend to compensate, by reducing induced investment, the expansionary effects of autonomous decisions to invest by innovators .

Since there is also the problem that in practice most gross investment includes technical innovations to some degree anyway and given that it is quite difficult to think that investors (whether “innovators” or not) are indifferent as to the capacity effects of their investment expenditures it seems better not to use the concept of autonomous investment at all.

That does not mean that a wave of innovative investment may not affect the level of effective demand of the economy or that all induced investment must be seen as “justified” by the level or growth of demand. “Unjustified” investment happens all the time, whether because of technical change or “animal spirits” or more generally because of the very nature of competition in a capitalist economy (one of Kalecki’s famous aphorisms says that “the capitalists do many things as a class, but they do not invest as a class”).

However, the best way to analyse those expenditures in a long period context is to consider a wave of innovative investment, which will possibly be “unjustified” in the aggregate, as an exogenous increase in the aggregate estimate of g , the expected trend growth rate of demand, while keeping all gross investment as induced so that we do not forget that the capital stock adjustment will be always operating. Thus, completing the quotation put on the top of this paper: "it seems to me that we should not make use of the concept of autonomous investment at all. We should regard exogenous events, such as innovations, as factors which influence the response of investment to the level of income and the size and character of the stock of capital" (Duesenberry, 1956, p.141)

If we do this we see in the output supermultiplier equation [7] above that a wave of “schumpeterian” innovative investment will have, by generating a once and for all increase in g , a level affect on the level of output since it does increase the aggregate marginal propensity to spend.

²³ Of course there is the alternative of assuming directly that autonomous gross investment has no capacity effect (and this is implicitly assumed in many cases e.g. by Kalecki [1971]). That however is not a solution for it simply means that “autonomous investment” is not investment at all but an autonomous "unproductive" expenditure just like consumption (Kaldor(1951), Duesenberry(1957))

However, this does not mean that a single increase in g can lead to a permanently higher rate of growth since, without an increase in the autonomous expenditures proper (Z), that would require that g_e implausibly keeps increasing continuously period after period. Thus a wave of innovations will probably have a level but not a growth rate effect on the output supermultiplier. The long period levels of output of the economy will first grow faster and then settle down back to the growth rate of autonomous expenditure but with a permanently bigger aggregate marginal propensity to spend (a larger output supermultiplier, see equation [8]).

When we extend the analysis to the secular process of accumulation and use the capacity supermultiplier we can see that this initial “autonomous” increase in g_e will gradually tend to be reverted as g_e is gradually revised in the light of the actual realised degree of capacity utilisation and the effects of the excess capacity generated are felt.

Thus the capacity supermultiplier shows that the capacity effects of any “unjustified” g_e are not lasting and thus the initial wave of investment will not tend to have a persistent capacity effect. Not only it will not have a persistent growth rate effect on capacity for the same reasons stated above but furthermore it not even have a persistent level effect on trend capacity (as opposed to long period output) because the capital stock adjustment process is continuously revising any given g and making it tend towards z , the growth rate of autonomous expenditures that do not create capacity.

Thus it is very unlikely that an acceleration of technical change can have by its direct effects on investment a persistent effect on the growth rate of the levels of output and capacity in the process of accumulation. In particular it is very hard to see how can a persistently higher trend growth rate of effective demand can be sustained through that direct route via “autonomous” investment decisions.

It can be objected that in any particular moment the competition between rival technologies may lead in some sector of the economy to an "unjustified" level of investment, that is investment that gives place to capacity that will not be used. In an unplanned economy, wrong/unjustified investment may be taken, on average over time, as a specific share of gross investment. The best way of taking into account this persistent amount of unjustified investment is to consider it as a persistent circumstance that rises the normal average capital output coefficient v .²⁴ In the specific (and strong) hypothesis that technical change is in any moment

²⁴ Alternatively, wrong/unjustified investment could be assimilated to other non-creating capacity business expenditure. Like these other autonomous business expenditures, also wrong investment is likely not completely independent from expected Effective Demand, as long as the

unexpectedly affecting some sector of the economy, it is possible to maintain that the aggregate level of investment is persistently increased above the level justified by the pattern of Effective Demand. This effect, if sufficiently persistent, will result in a level effect (since it increases the capital coefficient k) and not in a growth rate effect.

Another way through which intensification of technological competition may directly increase effective demand is if it leads to increases in autonomous business expenditure in research and development. Note however that R&D is not innovation but expenditures made to search for innovations and thus increases in R&D may be the direct effect on increased competition but they are not direct effects of technical change per se (for they are one of its causes). In the most industrialised countries, firms spend significant amounts on private R&D expenditure that, according to our classification, is an autonomous component of Effective Demand. An increase in the rate of growth of R&D expenditures will increase the levels and rate of growth of autonomous expenditures (Z and z) and thus have a growth rate effect on the long period output supermultiplier (equation 7) and both a growth rate and level effect on the capacity supermultiplier (equation 8).

3.7.2. Effects of technical change on the capital-output and depreciation coefficients

Technical change will have persistent effects on gross induced investment according to the effects of technical change on the capital-output and replacement coefficients. Changes in these coefficients will affect the marginal propensity to invest in both the output and the capacity supermultipliers. By thus changing the value of the supermultiplier(s) changes in the replacement coefficient or the capital-output ratio will cause level effects both on long period output and the trend of productive capacity.

Faster technical change may cause an increase in the replacement coefficient d . This may be due to the faster economic obsolescence of plants that may follow both product and process innovations. The competitive process can lead *within* the sectors subject to technical change to the *early replacement* of capital goods, also causing a higher level of gross investment.²⁵ This would be a *level* effect on the marginal propensity to invest. As said, this

expectations concerning Effective Demand affect the intensity of competition between capitalists and, therefore, the likelihood of mistaken investment.

²⁵ "Whatever may be its effect on net investment, technical progress will normally raise gross investment, in so far as it hasten obsolescence and shortens the life of existing capital" (Matthews, 1959, p.68, quoted by Caminati, 1986).

early scrapping can also take place *between* industries through the establishment of new industrial sectors (characterised by new products) accompanied by the decline of old sectors (Garegnani, 1962, p.96).

However, even conceding technical change to be so persistent as to determine a systematic accelerated economic obsolescence of capital goods, some other circumstances, mentioned in the literature, may delay or reduce the effects on gross investment.

It has been pointed out that the expected shortening in the economic life of capital goods can lead to *capital-saving innovations* (Caminati, 1986), in which case the higher gross investment determined by the early replacement is compensated by the lower value of the new capital goods. In this case although d has increased, the capital-output ratio v has decreased and the net effect on the marginal propensity to invest is ambiguous.²⁶

It has also been argued that the expectation of further technical change may induce the *postponement* of the replacement until technology has settled (Caminati(1986), Rosenberg, 1982). This decision depends of course on the balance between, on the one hand, the losses that the firm may incur by the delayed introduction of the new machinery in terms of smaller market shares and of being held back in the learning process of new techniques; and, on the other hand, by the expected losses due to its short anticipated economic life. More in general, firms will have the convenience to substitute their plants according to the original depreciation plans, and the possibility of doing so depends on the competitive structure of the industry (Domar, 1948). In this latter case faster technical change does not systematically increase d and thus it has no clear effect of increasing gross investment.

Turning now to the capital-output ratio v , we know it will change according to the overall "bias" of technical change. Thus, if innovations are on balance capital-saving (in Harrod's sense) v will be reduced and technical progress will imply *lower* levels of gross investment and a decrease in the aggregate marginal propensity to spend.

²⁶ "Even when the prevailing empirical circumstances are such that a higher rate of embodied technical progress has the effect of shortening the [economic] life of machinery, an increase in gross investment does not follow of necessity. To the extent that the shortening of equipment life is foreseen it may induce capitalists to adopt fixed capital-saving methods of production" (Caminati, 1986). Caminati provides other reasons why the effects of technical change on gross investment could be negative. For instance, the change in relative price brought about by the innovation in one sector might *in principle* determine *in other sectors* the delay rather than the anticipation of the scrapping of machinery. Also in this case the author concludes that "the proposition that embodied technical change fosters earlier scrapping of machinery is far from being general" (p.125).

Of course if technical change is Harrod-neutral v will remain unaffected. On the other hand if technical change has a capital-using bias v will increase and with it the levels of gross investment and the marginal propensity to invest.

Note however that in this latter case, while technical change clearly has a positive effect on gross investment, we cannot be sure it will have an expansionary effect on aggregate demand as whole. For as we know from the classical analysis of switching of techniques (and the Okishio theorem, see Steedman, 1977, ch.9), a capital-using system (i.e. one with a lower maximum rate of profits) will only be cost minimising if it saves enough labour so that the normal rate of profits does not fall. That means that such techniques will only be adopted if wages lag behind the increase in output per worker. But this associated change in the distribution of income is bound to have a depressive effect on the economy's marginal propensity to consume.

We conclude that when technical change is capital-using and thus the marginal propensity to invest increases, we cannot be sure because of the negative effect of the associated change in distribution on the marginal propensity to consume that the economy's aggregate marginal propensity to spend and the supermultiplier will increase or decrease (v will increase but s also will).

3.7.3. Technical Change and Consumption patterns

Innovations are traditionally classified in product and process innovations according to whether they create new products or change production processes. This is clearly not an entirely satisfactory classification since for instance a new machine is both a new product and changes production processes. Moreover even in what regards consumer goods and services process innovations often are what creates or at least renders possible many product innovations as "The fall of production prices that follows process innovations, if substantial, may have the same effects of major product innovations insofar as it makes possible mass consumption of previously inaccessible products and services" (Garegnani, 1962, p.98).

In any case we can still analyse particular innovations in what regards their impacts on production process and on the demand for new or at least differentiated products.

In general the process aspect of innovations has an impact on the economy's marginal propensity to consume through their effect on the rate of profits and the share of wages. If the

long period impact of innovations is to leave the normal rate of profits and the share of wages unchanged then there will be no impact on the marginal propensity to consume. On the other hand if technical change leads to a higher normal rate of profits and a lower wage share then the marginal propensity to consume will decrease (s will increase) and with it the long period level output and the productive capacity via the supermultipliers of equations [7] and [8] above.

To the extent that innovations generate new or differentiated products they may actually increase or at least prevent the decrease of the aggregate marginal propensity to consume. Indeed new products are very important to counteract the tendency towards saving when individual incomes rise. This product aspect of innovations is important to sustain a high marginal propensity to consume out of wage income.

In a closed economy the most direct route by which the product aspect of innovations has a decidedly positive impact on the growth of aggregate demand is through the effects of the continuous introduction of new products on the growth of autonomous consumption.

In fact the continuous introduction of new and differentiated products may help to explain the stylised fact of the rough long run constancy of the average propensity to consume in advanced capitalist economies. The average propensity to consume depends both on autonomous consumption and the marginal propensity to consume. Even if the latter is constant (or decreasing) , this could easily be compensated by the continuous growth (or acceleration) of autonomous consumption so to leave the average unchanged.

By continuously creating new needs and by making consumer durables quickly obsolete, product innovations may foster autonomous consumption both of the working classes (the more, the more income distribution and consumers credit are favourable to mass consumption) and of the wealthier classes (that can also use their financial wealth to have access to new products). Note however that in order that these new products have a positive impact on the growth of effective demand it is necessary that these innovations do not simply replace older products of the same value and that the economy's credit and financial system allows the liquidity for the accumulated wealth and/or the new purchasing power necessary for the expansion of autonomous consumption. ²⁷ A stream of product innovations may thus increase the rate of

²⁷ The relative relevance of innovations to maintain the average propensity to consume constant compared to the growth in per capita incomes and financial innovations has not been beyond dispute. Compare for instance the positions of Lance Taylor and Duesenberry. The former argues that: 'Household happily dissave to switch to innovative products as they appear - how many staples of the 1990 advanced economy consumption baskets (VCR's, Fax machines, shopping centres, sushi bars) even existed ten years before? As Pasinetti (1981) emphasises

growth of autonomous consumption and, consequently, that of autonomous demand z and have the effect of increasing the rate of growth of long period output and the longer run trend of productive capacity.

The expansion of effective demand due to product innovations justifies gross investment that gives place to additional capacity.²⁸ This gross investment, however, although associated to technical progress cannot be considered "autonomous" since it is induced and justified by the expected growth of effective demand. In other words, the investment associated to product innovations cannot be taken as exogenously determined, but are better treated as *induced* by the growth of effective Demand stimulated by those product innovations.

In conclusion, the innovation related investment has to find a justification on the effective demand side, either by displacing competing capacity which is early scrapped, or by increasing effective demand through product innovations. Since innovative investment is linked to the *expectations* that the market will absorb the product at least at its normal price, then this investment has to be considered as induced.²⁹

Moreover, we can see then that the effects of technical change on consumption expenditures is very complex and can change according to different circumstances. The positive impact on effective demand of the product aspect of innovations has to be balanced against their process aspect and increasing returns that generally accompany the mass diffusion of

the genius of capitalism resides in forestalling an unemployment crisis by inventing new products to replace old ones as demand for them subsides' (Taylor, 1991, p.15). By contrast James Duesenberry argued that other explanations based on social and cultural factors, such as "an increased degree of urbanization cited by Kutznes... and the effects of increased liquidity and availability of credit cited by Tobin", let alone Duesenberry's own "relative income hypotheses", would "leave only very little room for the notion that the propensity to save would rise if new products were not continually being introduced" (Duesenberry, 1956, p.135). J.Duesenberry, Innovation and Growth, *American Economic Review*, vol. , 1956, pp.134-141. To be sure, Pasinetti (1981) himself linked the evolution of consumption patterns to the growth of per capita income. The role of credit to consumers and of wealth effects due to speculative bubbles in the stock exchange (also financed by the availability of liquidity from the banking system) in generating Effective Demand in the long run has been explored by Steindl (1982).

²⁸ The case in which a new product displaces an old one correspond to the case of the early scrapping of old equipment that is treated in section 3.7.2.

²⁹ Completing the quotation put on the top of this paper: "it seems to me that we should not make use of the concept of autonomous investment at all. We should regard exogenous events, such as innovations, as factors which influence the response of investment to the level of income and the size and character of the stock of capital" (Duesenberry, 1956, p.141).

new products. On the one hand, the fall of production prices that results from mass production allows the mass consumption of previously inaccessible products and services. On the other hand, by displacing workers in production, mass production may weaken workers' bargaining power shifting distribution away from wage-income, something that depresses the aggregate marginal propensity to consume (cf. Arestis, Howells, 1995). As a result, the potential positive effects of the product aspect of innovations on Effective Demand has to be considered in view of a host of additional circumstances, in particular income distribution, the availability of cheap consumer credit and institutions that give liquidity to the accumulated wealth.³⁰

3.7.4. Exports and the propensity to import

Let us finally consider the magnitudes associated to the foreign trade performance of a single country. Theory and the historical experience suggest that technological advantages are a main determinant of the growth of *exports*. The single most important expansionist effect of technical change for a particular economy is the increase in the growth of exports that it can bring. The faster growth of exports leads to a higher growth rate of autonomous demand z and thus to a faster growth of long period output and capacity through the supermultipliers.

Other factors, in particular the foreign exchange rate policy, can of course affect the establishment of a virtuous circle between export performance and productivity growth (Kaldor, 1971). Technological advantages reduce also import penetration, which has a level effect by increasing the economy's domestic marginal propensity to spend (reductions in m decreases s).

Note however that these open economy effects cannot of course operate for all countries simultaneously. It is of course not possible for the world economy to grow through increasing its share of world exports and reducing its import share. The expansion of world trade inevitably depends on the expansion of domestic effective demand at many countries simultaneously.

3.8. Effective demand as a "compensation" mechanism

The analytical contribution of the preceding paragraphs has been the orderly classification the possible effects of innovations on Effective Demand by using a supermultiplier model summarised by equations [7] and [8].

³⁰ For an interesting historical analysis of technical progress and mass consumption patterns in the american economy in the 20th century based on the same approach we are following here see Medeiros(2000).

What can we conclude about the Neo-Schumpeterian thesis of compensation effects on the effective demand to the Ricardian technological unemployment?

As we have seen many aspects of technological change affect positively the long period level of effective demand. However many other aspects affect aggregate effective demand negatively or not at all. Moreover the supermultiplier analysis makes it clear that even when the effects of innovation on effective demand are positive they often constitute only level effects that are not capable of sustaining a higher trend growth rate of effective demand. It is also clear that the expansionary macroeconomic effects of technical change often depend crucially on the macroeconomic economic policy regime in terms of fiscal, credit, exchange rate and income policies and thus there is nothing “automatic” about them , since under different policies they may simply not happen.

The Neo-Schumpeterian compensation thesis requires that a higher growth of output per worker should in the long run automatically (and not as policy choice) lead to a compensating increase in trend growth rate of effective demand .

As we have seen not only it is not clear that faster technical change will automatically increase the trend growth rate (in the closed economy) but even in cases in which it did there is absolutely no reason or mechanism to ensure that this increase in the growth rate should be enough to match the growth of output per worker.

Therefore not only the neoclassical compensation story via factor substitution but the Neo-Schumpeterian compensation thesis through effective demand must be also be rejected.

3.9 Expansionary Macroeconomic Policies and endogenous technical change

The thesis that there must be some strong automatic compensating forces is usually supported by reference to the fact historically in some regions and some periods of very fast technical change have been periods of relatively fast growth both of the economy and employment.

In particular countries and periods this often can easily be explained by export-led growth as these countries with fast technical progress quickly increase their shares in the world market .³¹ But what about the “golden age” period of fast growth in most of the developed

³¹ See Medeiros & Serrano(1999).

countries from the end of WWII to the early seventies, which has been a period of fast growth in output per worker and at the same time of a high rate of job creation ?

In our point of view the explanation of this latter experience requires that we take into account two factors. First, that these years were characterised by a very expansionary international macroeconomic regime in which expansionary policies in the USA (particularly in what regards government spending) and the special position of the dollar as the international currency allowed export led growth in many developed countries ³² Also the most recent Clintonian period of US expansion, characterised both by employment and productivity growth, seems to have been fostered by the effects on autonomous and induced consumption of a financial bubble favoured by an easy access to bank liquidity (Sergio will provide quotations New Left Review dec 2000).

Second, that due to increasing returns, learning by doing effects, etc. there is a strong endogenous element in the growth of output per worker.

Indeed, a number of scholars have questioned the traditional causal relationship from innovation to economic growth, arguing that the spur of innovations are the rates of growth of aggregate income. For instance, economic growth induces a greater division of labour, facilitates the penetration of new products, and stimulates innovative activities by accelerating the recovery of their costs before innovations are imitated.³³

What the historical experience seems to be showing is that fast growth of aggregate demand allows inventions to turn into innovations and thus make output per worker grow faster. It seems that fast technical change is only compatible with fast growth of output and low levels of unemployment when and if it comes together and is in fact a result of an expansionary macroeconomic environment. There seems to be no automatic mechanism at work.

4. Conclusions

The essential theoretical feature of this paper lies in taking what could be called an Effective Demand approach to the study the long run impact of technical change on employment. Having shown how Effective Demand determines the rate of growth of the

³² Cf. Pivetti (1992), Stirati et al. (1999), Medeiros & Serrano(1999) .

³³ One of us has named this point of view 'Smithian', cf. Cesaratto (1999c) for an analysis and further references .

economy, it follows that the rate of growth of employment will depend on the difference between the growth of aggregate demand and the rate of growth of labour productivity. Using a supermultiplier model of long period Effective Demand, we have examined the various channels whereby innovations may positively affect Effective Demand. A first result is that the impact of innovations cannot be considered in a vacuum, that is without taking into account considerations that include the kind of technical change, income distribution, the availability of consumers' credit, the reaction of firms to the pace of technical change, and the reverse causation from income growth to technical change. Secondly, even allowing that the prevalent circumstances are favourable to a positive impact of innovations on aggregate demand, this is not enough to conclude that the pattern of Effective Demand will be high enough to compensate labour productivity growth. The main conclusion that stems from our analysis is that technical change is not a sufficient explanation of long run economic growth, let alone a sufficient force to keep the economy on a full employment path. Hence, technical change can be the cause of persistent unemployment quite independently of the existence of the various kinds of market imperfections and rigidities stressed by neoclassical theorists .

Having said that, however, we do not think it is appropriate to attribute the current high levels of unemployment in most European countries to technical and structural change. By definition the increase in unemployment is the result of the growth of productivity being greater than the growth of output. But the former has also been slow in the eighties and early nineties in comparison with the earlier part of the post II world war period so that the high unemployment level appears to be the result of the slow output growth, in turn the outcome of slow growth of long period Effective Demand which is the result of the progressive abandonment of the expansionary macroeconomic policies in most developed countries since the mid-seventies (Stirati et al, 1999).

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