Technical Progress, Market Forms and Unemployment*

Sylos Labini's article in a recent issue of this journal (Sylos Labini 1987), examines some of the factors that appear to have been important in the upsurge of unemployment in developed economies in the 1970s and 1980s. Within that article he returns to a consideration of the possibility of technological unemployment and to the effects of differences in market forms on the diffusion of the benefits of technical progress, which he had raised in an earlier work (Sylos Labini 1969). The purpose of the present paper is threefold: to emphasize the importance of the insights to be found in Sylos Labini's work; to extend it by distinguishing between the different types of technical progress: and to comment on his comparison of Ricardo and Keynes on the possibility of technological unemployment. Sylos Labini describes technical progress, in the two works cited above, as "labour saving" whether it is autonomous or induced by higher wage rates. It will be shown that a more comprehensive description would be useful for his purposes. For example, Ricardo's technological unemployment is most likely associated with technical progress that can be described as "capital-using and labour-saving", and that is not clearly superior to the technology it displaces. This displacement occurs because of the cost of labour relative to the cost of machines.

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1. Price determination

The manner in which prices are determined affects the process and speed of diffusion of the benefits of technical progress. Sylos Labini's approach to price determination in oligopoly is "dynamic" in the sense that it sees prices being established on the basis of estimates of their effects on events over time. Price leaders set prices with regard to their consequences on the firms' fortunes over time, and they are particularly concerned with the effects of their prices on the actions of other firms in the industry and on potential entrants. "... in a situation of oligopoly the main purpose of the large firms, which control the price, is to keep new firms out ... businessmen, while generally in a position to fix the price — which they could not do under competition — have a narrow zone of discretion, just because they are afraid that firms operating in other markets or new firms may invade their market or that existing ones may expand" (Sylos Labini 1969, 51). This policy does not conflict with long-run profit maximization — even though it is at variance with the short-period profit maximization of neoclassical theory — since current prices are set with a view to protecting the firm's market position over time. Long-run profit maximization — and its concerns with the impact of current decisions on future prospects — cannot be said to result from any simple rule, such as the equality of marginal revenue and marginal cost, since it involves "a complex strategy ... [and] while the problems involved in this strategy can be subjected to rigorous analysis, they cannot be reduced to one single mathematical formulation that in any way resembles that of marginal analysis" (*ibid*, 101).

The price policies of oligopolists are made operational through the use of markups on unit direct costs that allow firms to adjust to changing costs in ways that are consistent with their long-term objectives. These markups are designed to cover, when plant is operated at some "target" or "standard" percentage of productive capacity such as 80 per cent, all overhead costs, and to provide a "target" or "satisfactory" rate of profit when the resulting output is sold at the prices they determine. The target rates of profit, and the standard rates of capacity utilization, reflect the conditions surrounding (in particular the barriers to entry), and the experiences of, oligopolistic firms, and are subject to change over time. The explanation of the pricing behaviour of firms in a particular industry over time thus requires knowledge of the special conditions in that industry over time.

Price behaviour in oligopolistic and competitive markets is contrasted by Sylos Labini in the following ways: "In oligopoly, as well as in competition, prices depend on costs, but unlike competition, prices depend on costs not only in the long run but also in the short run" (Sylos Labini 1984, 23). Short-period variations in demand in oligopolistic markets that do not affect unit costs thus tend to be reflected in variations in outputs rather than in prices. The tendency for competitive prices to approximate costs of production in the long run, referred to in this quotation, depends on the stationarity of conditions over a fairly long period of time (*cf.* Marshall 1920, 347). Under such conditions, investment decisions that are based on differences between current prices and the current long-period equilibrium prices, would lead to the changes in productive capacity that eventually result in prices that just cover the normal costs of production. When conditions are not stationary, these investment decisions would not produce such a result, even after the passage of a long run of time. Even in the latter case, however, "long-run forces" are always at work in the short run, in the sense that when we look at a sequence of short periods we find differences in productive capacity and technology that are a result of carrying out investment decisions. The power and importance of long-run forces are thus always in evidence in a changing world, even thought they do not lead to some long-period equilibrium "in the long run", because of the unforeseen changes that keep recurring. As Lerner (1962, 449) observed, "[I]n the long run, unless we are indeed all dead, we will still be in the short run".

2. The diffusion of the benefits of technical progress

The differences in market forms, with their consequences for price determination, also affect the distribution of the fruits of technical progress, and its implications for further growth. Sylos Labini characterises the position of the classical economists, with their emphasis on the forces of competition in free markets, as one where the benefits of technical progress are spread throughout the economy by the lower prices resulting from this competition when costs of production are decreased by technical progress. The higher profits made initially by the entrepreneurs who are the innovators, lead to increases in total

investment and output, and they thus help to promote employment. The lower prices resulting from technical progress in any industry, tend to increase real incomes even of those engaged in other industries. Under oligopoly, in contrast, the barriers to entry that serve to limit competitive pressures, make it possible for many of the benefits of technical progress to be retained indefinitely within the innovating firms through higher relative profits and money wages. The barriers to entry protect the workers and their incomes in a particular industry, as well as the profits of the oligopolists, because these barriers serve to keep out the products that could otherwise be produced by lower-paid workers. (It is thus not surprising to find that in situations where barriers to entry are made less effective — for example, by the pressure of foreign producers (as in the U.S. automobile industry), or by the "deregulation" of industries in which entry had been controlled by governmental bodies (as in the U.S. airlines industry) — that workers are often forced to accept reductions in their money-wage rates and/or fringe benefits.) On the value of these barriers to entry to workers, Sylos Labini writes: "If we consider the incomes (profits and wages) accruing to those who belong to a certain oligopolistic (or monopolistic) industry or set of industries, these incomes may durably and considerably exceed those of other industries, where market forms closer to competition prevail" (Sylos Labini 1969, 126). In these industries, therefore, "the prevailing tendency is for the fruits of technical progress to be distributed through rising money incomes rather than through falling prices" (*ibid.*, 127).

The level of employment is subject to opposing forces as a result of technical progress that can be characterised as "labour-saving", and which requires the production of new machines. Investment tends to be encouraged by the boost to the inducement to invest provided by the market for the new machines, but fewer workers are then required to produce any given level of output with these machines. The net effects on employment of technical progress, given its characteristics, depend on how the factors determining effective demand are affected. In order to focus attention on the employment effects of different types of technical progress, and of different market forms, it will be assumed that initially the introduction of new machines takes place without any change in the rate of investment. (Sylos Labini — 1969, 154 — made a similar assumption.) The improved machines are assumed to be produced instead of the older ones, but employment, wages, and the markups in the investment sector are unchanged.

3. The classification of technical progress

Only two production sectors — those for consumer goods (referred to as C-goods) and capital or investment goods (referred to as I-goods) — appear in the model presented here. They are sufficient to allow for the main types of technical progress referred to in the literature. The new machines are produced with the same amount of labour, and over the same time period, as the old machines. A physical measure of labour productivity in both sectors is possible if it is assumed that the basket of consumer goods is unchanged by the technical progress whose consequences are being examined. This assumption is due to Robinson (1956, 97 and 1960, 75-6) (it also appears in Hicks 1971, 923), and it is not inconsistent with the approach taken by Sylos Labini. C-goods plants are assumed to have a well-defined physical productive capacity (*e.g.* "[T]o each type of technology there corresponds an establishment of given size, capable of producing a volume of output not exceeding a certain upper limit ... Direct cost is taken as constant up to that limit and so equals marginal cost" — Sylos Labini 1969, 38), and the output of workers in the investment-goods sector can be measured in terms of the consumer-goods sector productive capacity they produce. Let a be the output per man in the C-goods sector (expressed in units of the C-goods per man-hour) when plants are operated at normal productive capacity, while i is the output per man in the I-goods sector. It is measured by the C-goods productive capacity produced per man in the investment-goods sector, that is, by the amount of C-goods that would be produced if the plant is operated at normal capacity, divided by the number of man-hours required to produce that plant (as well as to produce whatever equipment is necessary for this purpose). The units for i are thus the same as those for a, but the man-hours referred to are those of workers in the I-sector.

Sylos Labini does not use this notation, and he refers to the case he examines as one where "... in the consumer-goods sector technical coefficients are reduced. I have in mind especially a reduction in the labor coefficient due to the introduction of the new, improved machines" (*ibid.*, 154). In the other sector "there are quality changes — an increase in the technical efficiency of each machine — without changes in technical coefficients ... [and] the same number of machines continues to be produced, so that employment in the machine sector

remains stable" (*ibid.*). These statements are not sufficient to distinguish between the possible types of improvement in the technical efficiency of the new machines. They may have the same productive capacity as the old ones (this can be expressed in our notation as $\hat{\imath} = 0$, where $\hat{\imath} = (1/i)\, di/dt$), while requiring fewer workers to operate them ($\hat{a} > 0$); or they may have increased productive capacity ($\hat{\imath} > 0$), while not requiring a correspondingly larger number of workers to operate them ($\hat{a} > 0$). In the latter case, if the number of C-sector workers per machine is unchanged, then the increase in labour productivity is the same in both sectors ($\hat{a} = \hat{\imath}$). There may also be technical changes that do not result in a *superior* technique, where output per man in one sector is increased, but it is decreased in the other. These technical changes can be economically advantageous, given the level of wages and interest rates, because they decrease the total costs of production. Such technical developments can be said to result simply in changes in the *degree of mechanisation* (Robinson 1962, 92). The employment consequences of each of these cases, other conditions given, would be different, and it would thus be useful to list the possible types of technical progress in this model before considering the employment consequences of different market forms. Technical progress is not only dependent on the introduction of new machines, it can also occur through the more efficient use of existing equipment. For example, both output per man and productive capacity in the C-goods sector could increase as a result of organizational changes that increase efficiency. (Sylos Labini sees these changes as the results of increases in wages relative to the prices of products that lead managers to make "more rational use of workers at the same level of production" — Sylos Labini 1987, 393.) Such changes would also be reflected in our measure of productive capacity in the I-sector, even though nothing has been altered in the latter, because this measure is based on the productive capacity of plant produced for the C-sector.

The classification of technical progress in Table 1 is based on that in Asimakopulos and Weldon (1963). The three main categories correspond to Harrod's (1948) threefold classification of technical progress, and they indicate the direction, if any, of the change in the ratio of the number of workers required to operate a C-goods sector plant at a standard rate of utilization, to the number of workers in the I-goods sector required to build that plant. If l_I is the number of workers required in the investment sector in one period, to produce a plant employing l_C workers in the consumption sector, then we have, by

TABLE 1

CLASSIFICATION OF TECHNICAL PROGRESS

Neutral	Capital-using	Capital-saving
$\hat{a} = \hat{\imath}$	$\hat{a} > \hat{\imath}$	$\hat{a} < \hat{\imath}$
(i) Capital-neutral, labour-saving $\hat{a} = \hat{\imath} > 0$	(ii) Superior capital-using, labour-saving $\hat{a} > 0; \hat{\imath} > 0$	(iv) Capital-saving, labour-saving $\hat{a} > 0; \hat{\imath} > 0$
	(iii) Capital-using, labour-saving $\hat{a} > 0; \hat{\imath} < 0$	(v) Capital-saving, labour-neutral $\hat{a} = 0; \hat{\imath} > 0$
		(vi) Capital-saving, labour-using $\hat{a} < 0; \hat{\imath} > 0$

definition, $l_I \,.\, i = l_C \,.\, a$. Therefore, $l_I/l_C = a/i$, from which it can be deduced that the proportionate time rate of change in the ratio of employment in the two sectors ($\hat{l}_I - \hat{l}_C$) is equal to the difference in the proportionate changes in the outputs per unit of labour in operating, and building, a C-sector plant ($\hat{a} - \hat{\imath}$). No change in the ratio of employment is required with neutral technical progress, but relative employment in the I-sector increases with capital-using technical progress, and decreases with capital-saving technical progress.

Before proceeding to examine the effects of different market forms on employment, for various types of technical progress, it is necessary to outline briefly a simple Kaleckian model that provides the macroeconomic framework for this study.

4. The determination of employment in a Kaleckian model

We examine here for purposes of simplification, only a closed economy with no government economic activity, and no workers' savings. Gross profits in this Kaleckian model (based on that presented in Asimakopulos 1975) are equal to the sum of gross investment (I) and capitalists' consumption expenditures (C_C). We can thus write $P = I + C_C$. It is assumed that the situation examined is one of short-period equilibrium, and that capitalists' consumption expenditures are a

function of current profits. We thus have $C_C = (1 - s_P) P$, and thus $P = I/s_p$ where s_p is the propensity to save out of profits. (If β is the proportion of current profits distributed as dividends and in interest payments, and s_r is the propensity to save out of interest and dividend incomes, then $s_p = 1 - (1 - s_r) \beta$.)

In the following equations, μ_C, μ_I are the markups in the C-goods and I-goods sectors respectively; w_C, w_I are the money-wage rates in each of these sectors; and L_C, L_I are the respective levels of employment.

The value of investment expenditures (and output), I, is equal to the marked-up value of the wage bill in the investment sector (given that all firms are fully integrated, producing their own raw materials). This can be written as

$$I = (1 + \mu_I)\ w_I\ L_I. \tag{1}$$

When this expression for I is substituted into the profits equation, we have

$$P = (1 + \mu_I)\ w_I\ L_I/s_p. \tag{2}$$

The exogenously given level of investment in real terms will determine the level of employment in the investment sector, while an equation showing the determination of the level of employment in the consumption sector can be derived from the definitional relation between the sum of the gross profit margins in the two sectors and total gross profits:

$$\mu_C\ w_C\ L_C + \mu_I\ w_I\ L_I = P. \tag{3}$$

When equations (2) and (3) are combined, and rearranged, we obtain for employment in the consumption sector

$$L_C = \frac{w_I\ L_I\ [1 + (1 - s_P)\ \mu_I]}{s_P\ \mu_C\ w_C}. \tag{4}$$

The value of L_C is directly related to the level of employment in the I-goods sector, and given the value of the wage-bill in that sector, it is also directly related to the markup in the I-goods sector. It is inversely related to the propensity to save out of profits and to the markup in the consumption sector. A larger wage rate in the I-sector relative to that

in the C-sector is favourable to employment in the latter. From equation (4) the proportional time-rate of change in employment in the C-goods sector $\hat{L}_C = (1/L_C)\ (dL_C/dt)$ can be derived, and its expression is shown by equation (5). (All variables marked with a $\hat{}$ represent time rates of change.)

$$\hat{L}_C = \hat{L}_I + (\hat{w}_I - \hat{w}_C) - \hat{\mu}_C + \frac{(1 - s_P)\ \mu_I\ \hat{\mu}_I - (1 + \mu_I)\ \hat{s}_P}{1 + (1 - s_P)\ \mu_I}. \tag{5}$$

In competitive markets the realized markups are affected by short-period changes in demand, with rates of return varying with demand. Sylos Labini examines the "long-run" situations where normal rates of profit are earned in competitive industries, and the changes in markups that are consistent with this result depend on the changes introduced by technical progress in the value of capital per worker. In the case of oligopolistic industries benefitting from technical progress, markups could be maintained at levels that provide higher than normal rates of return even "in the long run". Money-wage rates could also be increased relative to those in other industries, and this is why equation (5) allows for the possibility of different rates of change in money-wage rates in the two sectors. Given the simplifying assumptions that any production of new machines made possible by technical progress does not change either the labour requirements in the investment sector or the time patterns of production, and that money-wage rates, markups and employment in that sector are unchanged (*i.e.* $\hat{w}_I = \hat{\mu}_I = \hat{L}_I = 0$), equation (5) is reduced to

$$\hat{L}_C = -\hat{w}_C - \hat{\mu}_C - \frac{(1 + \mu_I)\ \hat{s}_P}{\hat{1} + (\hat{1} - s_P)\ \mu_I} \tag{6}$$

5. Markups and technical progress

The cost of plant per worker in the C-sector, k, can be written using our notation, as

$k = (1 + \mu_I)\ w_I\ l_I/l_C$, and since, by definition, $l_I/l_C = a/i$,

$$k = (1 + \mu_I)\ w_I\ a/i. \tag{7}$$

The gross one-period rate of return (r) when this plant is operated at the standard rate of utilization is equal to gross profits per man ($\mu_C\ w_C$) divided by the value of capital per man as shown by the right-hand side of equation (7).

$$r = \frac{\mu_C}{(1 + \mu_I)} \cdot \frac{w_C}{w_I} \cdot \frac{i}{a} \qquad (8)$$

The markups and labour productivities that appear in the above equations are average values over all firms and plants. Given the price (p) of the product in the C-sector, the average realized markup (μ_C) in that sector can be shown to have the following relationship to average labour productivity (a) in that sector, and the money-wage rate (w_C):

$$p = (1 + \mu_C)\ w_C/a, \text{ therefore, } \mu_C = a/(w_C/p) - 1.$$

The average realised markup in the C-goods sector is equal to average output per man-hour in that sector, divided by the hourly wage rate in terms of C-goods output, minus one.

Equation (8) shows the average rate of return in the C-goods sector. Technical progress due to the introduction of new and more efficient machines means that the profit margins in the newer plants will be higher than those earned on older vintages, but insofar as technical progress, in the broad, was foreseen this is not inconsistent with normal rates of return on older plants over their lifetimes. In this exercise we are examining the effects of a series of innovations, and are implicitly assuming conditions of tranquillity (*cf.* Robinson 1956, 59) while concentrating on the effects of different market forms and different types of technical progress. The assumption of tranquillity, even though it is unrealistic, permits concentration on the employment effects of different market forms, and of different types of technical progress. Tranquillity is a "legitimate" assumption in this very limited context, not because anything like tranquillity will hold in situations where technical progress is occurring, but because the conclusions reached about the consequent employment effects of different market forms are not likely to be significantly changed under more general conditions.

One further point should be mentioned before returning to the equations. The standard, or "normal", rates of utilization of productive capacity will be different for firms operating under competitive conditions than for those under oligopolistic conditions. The latter can afford to maintain extra productive capacity under normal conditions (its cost is built into their markups and prices), for use at times of unexpectedly

high demand, and as a deterrent to entry. This difference is not reflected in our notation, with l_C representing the employment when a C-sector plant is operated at a standard rate, without reference to the nature of the market form and the differences in standard rates of utilization. It is not necessary to introduce different notations for the two market forms for our purposes because only comparisons of rates of change of employment are used. The differences in the levels of employment offered by a plant when utilized at the different standard rates for competitive and oligopolistic conditions, do not appear in these comparisons.

From equation (8) we can derive the relation between the proportionate changes in the rate of returns, markups, wages and technical progress.

$$\hat{r} = \hat{\mu}_C + \hat{\imath} - \hat{a} + \hat{w}_C - \hat{w}_I - \frac{\mu_I}{1 + \mu_I}\ \hat{\mu}_I. \qquad (9)$$

If, as in the competitive situations examined by Sylos Labini, it is assumed that the rate of return is unchanged even when technical progress has been occurring, then equation (9) can be used to show the change in the markup in the C-goods sector that is consistent with this assumption. In oligopolistic situations, the markup is assumed to be set by the firms, and the rate of return in the C-sector may be increased.

6. Technical progress, market forms and employment

The effects on total employment of technical progress due to new machinery, given our simplifying assumptions about investment ($\hat{L}_I = \hat{w}_I = \hat{\mu}_I = 0$), can be readily shown for different types of technical progress and market forms.

(I) *Neutral technical progress* ($\hat{a} = \hat{\imath} > 0$)

(a) *Competitive markets* ($\hat{r} = 0$)

Competition would ensure that the wage rates would be the same in both sectors, and thus $\hat{w}_C = 0$. From equation (9) we can deduce that in this case $\hat{\mu}_C = \hat{a} - \hat{\imath} = 0$. When all the appropriate substitutions are made in equation (6), and it is also assumed that the propensity to save out of profits is unchanged ($\hat{s}_p = 0$), we find that this type of technical

progress, under these conditions, does not affect the level of employment ($\hat{L}_C = 0$).

This result is a consequence of the increase in the demand for the output of the consumer goods sector due to the fall in its price. We can write this price as $p = (1 + \mu_C)\, w_C/a$, and thus derive $\hat{p} = \hat{w}_C - \hat{a} + \hat{\mu}_C \,.\, \mu_C/1 + \mu_C$, and in this case $\hat{p} = -\hat{a} < 0$. This increased demand is just sufficient to keep total employment in the C-goods sector unchanged. The benefits of this labour-saving technical progress are shared proportionately by labour and capital, since its implementation does not require a change in income shares. The money values of both wages and profits are unchanged, with their real values being increased in terms of consumption goods.

(b) *Oligopolistic markets* ($\hat{r} \geq 0$, and $\hat{w}_C \geq 0$)

Protection from new competitors, at least for some period of time, makes it possible for firms in oligopolistic industries to earn above normal rates of return and/or for their workers to obtain above normal wage increases, when technical progress reduces their costs. Substitution of the coefficients for neutral technical progress into equation (9) shows that $\hat{r} = \hat{\mu}_C + \hat{w}_C$. From equation (6), when $\hat{s}_P = 0$, we can then deduce that $\hat{L}_C = -(\hat{\mu}_C + \hat{w}_C) = -\hat{r}$. In all cases where the technical change gives these oligopolists an opportunity to increase their rates of profit, total employment is lower than it would otherwise be. This increase in profits inhibits the increase in consumption that is made possible by the increased productivity in the consumer-goods sector, and thus results in unemployment. (It should be kept in mind during this discussion that the rate of investment is assumed to be unaffected by this technical change.) The increase in consumption that would prevent unemployment requires either that there be increases in money-wage rates in the C-goods sector that capture all the benefits of the technical progress, or that these wage rates increase by a smaller amount and that the price of consumption goods falls so that investment-sector workers and capitalists also increase their consumption. In both cases $\hat{\mu}_C = -\hat{w}_C$, while in the former $\hat{w}_C = (1 + \mu_C)\, \hat{a}$, so that $\hat{p} = 0$, while in the latter $\hat{w}_C < (1 + \mu_C)\, \hat{a}$, and this allows for a decrease in the price of the C-good.

Sylos Labini (1987, 389) returns to the numerical example he developed in an earlier work (Sylos Labini 1969, 137-49) to illustrate the possible employment effects of labour-saving technical progress, and makes a distinction between a short-term and a long-term process in the case of oligopolies. The former is marked by rigid prices, with either

profits or wages, in the sector where the new machines are employed, being increased to absorb all the benefits of the change. The long-term process is seen as ending in a return to equal profitability in all sectors, so that all workers who lost their jobs initially are eventually rehired. The only difference with the competitive case — apart from the passage of time that can be very costly to the individuals who had a spell of unemployment — is that the required increase in consumption demand is the result of higher money wages in all sectors and a constant price of output only in the sector using the improved machines. The analysis presented here, even though it only deals with two sectors of production rather than the three used by Sylos Labini, is sufficiently general to display his results.

(II) *Capital-using technical progress* ($0 < \hat{a} > i$)

(a) *Competitive markets* ($\hat{r} = 0$)

From equation (9) we deduce that $\hat{\mu}_C = \hat{a} - \hat{\imath} > 0$. The higher markups in the C-goods sector required to achieve normal rates of profit mean that total employment, given our usual assumptions, will be reduced, since $\hat{L}_C = -\hat{\mu}_C < 0$. The increase in markups, enforced by competitive pressures, prevent consumer goods prices from falling by the amount required to ensure that consumption demand in money terms is sufficient to re-employ all the displaced workers.

For any given value of $\hat{a}$, the smaller the value of $\hat{\imath}$, that is, as we go from case (ii) in Table 1 to case (iii), the greater the increase in the markup required to maintain a normal rate of profit, and the larger the reduction in employment. Hicks (1970) has identified Ricardo's "machinery effect" with the (non-superior) capital-using technical progress of case (iii). The adverse employment effects of capital-using technical progress may be hidden for some time if there is a burst of investment expenditures that are the result of the demand for new machines. Even if the profit rate is unchanged, the profit share in total income will be increased in this case, along with the proportion of total employment in the investment sector.

(b) *Oligopolistic markets* ($\hat{r} \geq 0$ and $\hat{w}_C \geq 0$)

The increase in the profit rate in the consumption sector made possible by the restricted competition in the short period in these markets and the new technology, add to the adverse employment effects of capital-using technical progress. With $\hat{r} = \hat{\mu}_C + \hat{w}_C - (\hat{a} - \hat{\imath}) > 0$, the decrease in employment in the C-goods sector is now greater than the

degree of capital-using bias, since $\hat{L}_C = -(\hat{\mu}_C + \hat{w}_C) < -(\hat{a} - \hat{\imath})$. In the limiting case where competition in the long-period sense is strong enough to restore normal profits, the adverse employment effects are equal, as in the competitive case, to the degree of bias in the technical change $[\hat{L}_C = -(\hat{\mu}_C + \hat{w}_C) = -(\hat{a} - \hat{\imath})]$.

(III) *Capital-saving technical progress* $(0 < \hat{\imath} > \hat{a})$

(a) *Competitive markets* $(\hat{r} = 0)$

This type of technical progress has more favourable consequences for employment than the other two because it tends to lead to lower prices of consumer goods and higher real wages, and thus to increased consumption. With the rate of profits unchanged, markups in the consumption sector are reduced $[\hat{\mu}_C = -(\hat{\imath} - \hat{a}) < 0]$. It follows from equation (9), under our usual assumptions, that employment is increased $(\hat{L}_C = -\hat{\mu}_C > 0)$. The increased demand for consumption goods is so great that, in spite of the higher output per worker, employment in this sector has to be increased. This category of technical progress tends to increase the wage share of total income, and a higher proportion of the work force is required in the consumption sector.

(b) *Oligopolistic markets* $(\hat{r} \geq 0$ and $\hat{w}_C > 0)$

This category of technical progress may result in higher employment even when the rate of profits is increased by the reduction in costs. The conditions for higher profits, $\hat{\mu}_C + \hat{w}_C + \hat{\imath} - \hat{a} > 0$, does not preclude that the sum of the first two terms in this condition is negative, since the combination of the last two is positive. It is thus possible for the change in employment $[\hat{L}_C = -(\hat{\mu}_C + \hat{w}_C)]$ to be greater than zero. This possibility becomes more likely the smaller the increase in the rate of profits and, in the limit, where long-period competitive processes work effectively to keep the rate of profits at its initial value, the employment effects are similar to those in the competitive case.

The preliminary nature of this examination of the employment effects of different types of technical progress and different market forms, should be emphasized. The market form may affect the rate of technical progress. For example, oligopolistic industries may originate more innovations because the barriers to entry might enable successful firms to appropriate a larger proportion of the benefits of their innovations, thus encouraging them to spend more on research and development and to invest more. In addition, the technological factors,

the larger economies of scale that lead to oligopolistic situations, might also make the development of innovations less costly under these circumstances.

The employment consequences of technical progress were examined under the assumption of no change in the value of investment and in employment in the investment-goods sector. But the implementation of technical progress, of new discoveries, might require and encourage increases in total investment expenditures. The complete employment consequences of technical progress, even of capital-using technical progress, might be more favourable than that indicated by the examples presented here, when the assumptions of an exogenously given rate of investment, and thus total employment in the investment sector, is relaxed.

7. Ricardo and Keynes on technological unemployment

Sylos Labini takes Ricardo's approach as his starting point for the consideration of technological unemployment. "But we must go back to Ricardo to find the question formulated in the proper terms... of dynamic substitution: the reduction in the use of labour and the increase in the use of capital goods as a result of an increase in wages which makes it worth while to use a new technology" (Sylos Labini 1987, 394).[1] If, as is implied by this statement, the new technology is only developed and adopted because of the increase in wages, then it falls under category (iii) in Table 1. This capital-using and labour-saving technical progress represents only a different degree of mechanisation; it is not clearly superior to the technology embodied in the machines being replaced. Its employment (unemployment) effects would become evident over time as new machines are utilized in the consumption sector. At any given rate of investment, with the propensity to consume unchanged, the level of employment would be lower than it would have been, under these conditions, with the displaced technology. Our examination of the different types of technical progress in the preceding section has shown that this is only one of the possible outcomes of

[1] He contrasts this with the neoclassical approach which is static, and that assumes this substitution can occur within a given technology as a result of changes in wage rates. "The neoclassical economists reason in terms of bidirectional and reversible relations" (Sylos Labini 1987, 394).

labour-saving technical change, and that other types have more favourable effects on employment prospects.

Keynes is seen as considering "only the nexuses of complementarity and not of substitutability between the means of production, and in particular between labour and capital" (Sylos Labini 1987, 394). But this comparison pays insufficient attention to the admittedly limited scope of Keynes's formal analysis in *The General Theory* that is confined to a short-period framework. Keynes takes as given the existing equipment and technology (Keynes 1936, 245), and examines only the factors determining the volume of employment (and output) with that given equipment. Labour and equipment are, in a sense, complementary in the short period with machines being idled when employment is decreased, and brought into activity when employment is increased. Keynes assumed these changes in employment led to decreasing returns, and thus real-wage rates and employment are inversely related (*ibid.*, 17). This could be due to the need to resort to older, less efficient equipment when output is increased, and/or to the use of less efficient labour (*ibid.*, 42). The complementarity referred to by Sylos Labini is, however, of a different kind, since he writes that "investment and employment vary in the same direction (complementarity), and not in opposite directions (substitutability)" (Sylos Labini 1987, 395), implying that substitutability is a possibility overlooked by Keynes. But in Keynes's short-period analysis they *must* vary in the same direction, because only the employment-creating effects, and not the productive-capacity creating effects, of investment are considered. The references to *The General Theory* given by Sylos Labini in support of his interpretation refer to the stability of the position of short-period equilibrium, and to the multiplier process, and are consistent with the position taken here. The first of the references he gives concludes a consideration by Keynes of the stability of the position of short-period equilibrium, and notes "that employment can only increase *pari passu* with an increase in investment; unless, indeed, there is a change in the propensity to consume" (Keynes 1936, 98). The second reference (*ibid.*, 113) refers back to the first one before leading into Keynes's development of the multiplier that shows the direct relationship between net changes in investment and employment, *given* technology and productive capacity.

Sylos Labini (1969, 153) argued that even within the short period context of his analysis, Keynes was not justified in ignoring changes in technical coefficients of production. "But the replacement of machines gradually wearing out affords *continual* opportunities for introducing

quite important changes in the technical coefficients... the assumption of technological change, therefore, can logically be applied also to the short period" (*ibid.*, italics in the original). It can be observed, without entering into the question of what can or cannot be legitimate abstractions in short-period analyses, that Keynes does not compare technical conditions in adjacent short periods, and the changes in technology that would be relevant in such a comparison do not appear. Sylos Labini's criticisms are, however, very pertinent to Keynes's informal reflections on the implications of his *General Theory* for the development of an economy over time (*ibid.*, 249-54). There is reference to the wearing out of capital equipment over time that sets the stage for a recovery from a recession, and the eventual decrease in the marginal efficiency of capital due to the increase in the stock of capital from the maintenance over time of a higher than normal rate of investment, but any consideration of the possibility that the maintenance of reasonable levels of employment over time may be made more difficult by the nature of technical progress, is absent in these reflections.

8. Conclusion

This paper has dealt with only some of the many important points raised by Sylos Labini about the growth and persistence of unemployment. In particular, we have concentrated on those that appeared in his 1969 book, as well as in his 1987 article. There is a strong thread of continuity in his views — concern over the possibility of technological unemployment, and the way in which a resonable adjustment to the disruption caused by technical change may be impeded by the policies of oligopolistic firms — even though more attention is paid in the article to the labour market and to the potential strengths of small and medium-sized firms. We have noted that the severity of the problem of technological unemployment depends on the character of technical progress, but Sylos Labini was aware of the special nature of some of the assumptions made in his 1969 study. He saw it as a preliminary examination of a complex problem. "...we are led to formulate a first hypothesis to explain the stagnation of employment after the First World War: the forces tending to absorb unemployment were weakened because the field of action of the oligopolistic mechanism expanded at the expense of the classical mechanism of competition.

Thus, our analysis so far appears to be useful in two ways. In general terms, it shows how different are the effects of technical progress on income and employment according as one or the other mechanism is in operation. In more specific terms, it offers a hypothesis for the explanation of the phenomenon which goes under the name of equilibrium unemployment" (Sylos Labini 1969, 160).

The ability of these oligopolistic firms to finance much of their expansion through the use of retained earnings, is also a cause of concern to Sylos Labini because of the barriers this tends to place to the free flow of investment funds into all industries, and that might result in the unproductive use of some of the retained earnings. Unless demand expands rapidly enough, oligopolistic or monopolistic profits may yield more disposable funds than are required for self-financing and these may be kept in liquid form or employed "unproductively" (*ibid.*, 186).

Sylos Labini has highlighted some potential employment consequences of the spreading of oligopolistic markets, and of technical progress, that merit further study.

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