THE REGULATION OF OLIGOPOLY AND MONOPOLY

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Abstract. *This paper states that the main difference between oligopoly-monopoly and competiveness is the freedom of entry into the market. This is present in competitiveness, is absent in monopoly, is almost absent in oligopoly. The main effect is that regulatory devices should regard the field of oligopoly. There is a situation of oligopoly-monopoly when it is impossible to enter the market. Unit production expenses, after an initial treat descent, tend to be linear on the horizontal axis. Commercial expenses show instead structurally increasing returns, and these are the real obstacles to the market enter. Entrance implies in fact small quantities sold initially, and previously established firms are privileged. The state of regulations depends strongly on these situations. Competitiveness should not be regulated, even when the demand is partially inelastic. Regulation implies a variety of interventions:* ***a)*** *special prices for public enterprises in monopoly services;* ***b)*** *a contrast of every organization which establishes the "right of workers" above "the right of consumers" in the monopolistic public sectors;* ***c)*** *a differentiated rate, relatively high and international, in order to control the excess return on investment in oligopoly.*

Keywords: Oligopoly; Natural monopoly; Possibility of entering the market; Types of regulations; Fiscal intervention

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1. Introduction

The economic theory is still dominated by the U form of average costs in economics, in spite of its enormous contradictions[1]. We will show in this paper that increasing returns have disruptive effects. In spite of this, they have not been

[1] In this matter now the hypothesis of capital given dominates, i.e. the capital invested is posited. Then the **U** form of costs comes forth. Monopoly and competitiveness are often confronted, and the usual advantages for competitiveness (a greater quantity produced, at a minor price) emerge. In this context, nobody notes the absurdity of the hypothesis of capital as given. The consequence of the confrontation between competition and monopoly, at parity of total demand, is that the **U** curves should be equal in the two cases, both in competition (which is obvious, since there are many firms) and in monopoly. In the latter case, at whatever level of quantity, the same minimum average cost as in competition holds, otherwise there would be an asymmetry. In monopoly the price is higher, but, as just outlined, this does not mean that average cost is met in its descending phase (otherwise in competition, firms being smaller, the equilibrium would come in the descending phase). The implication is that the capital must be minor in monopoly (and not equal, as it is usually reported), and must be at the same minimum average cost as in competition. In formal terms, positing that demand is a straight line:

$$\pi = (p - c_{mm})Q = (p - c_{mm})(p_{max} - p/d) \rightarrow \delta\pi/\delta p = 0 = pp_{max} - p^2/d - c_{mm}p_{max} + c_{mm}\,p/d \rightarrow + p_{max} - 2p/d + c_{mm}/d = 0 \rightarrow p = 1/2\,(p_{max}/d + c_{mm})$$

in which π are total profits; **p** is the price of product; c_{mm} is the minimum average cost; **Q** is the quantity produced; p_{max} is the intercept with the ordinates when quantity is zero and **–d** is the angular coefficient of the relation $Q = p_{max} - dp$ (from this relation **Q** is derived in the second passage of the expression above); $\delta\pi/\delta p = 0$ is the usual formula for maximum through which the equilibrium **p** is found. The result means that the price in monopoly is equal to half of the sum between: a) the maximum price (i.e. when the demanded quantity is zero) divided by the angular coefficient; b) the price of competition (which corresponds to the minimal average costs). This is true also for the average cost curve outlined in section **2**. In Sraffa (1925) these results are clearly stated. In Sraffa again (1926, p. 9 and ff.) the point of maximum profit is when the absolute value of elasticity of demand is one. This happens also in this procedure. In fact it is:

$$e = -\delta Q/Q/\delta p/p = -\delta Q/\delta p/p/Q = -1/d\ 1/2\,(p_{max}/d + c_{mm}) / d/2(p_{max}/d + c_{mm}) = -1$$

in which $-\delta Q/\delta p = -1/d$; $1/2\,(p_{max}/d - c_{mm})$ is the solution for **p** above; while the expression $d/2(p_{max}/d + c_{mm})$ is the corresponding quantity.

massively studied. Sraffa, with his articles in 1925 and 1926, posited the problem, by attaching decreasing returns. Important economist then followed, among whom were Steve (1976) and Leijhonfvud (1985). Most importantly, all the managerial textbooks, and even the textbooks written by the Taxation Law Professors (see Lupi, 2019), take for granted the existence of increasing returns.

In section **2** we set the question again: a) in a context of technological progress; b) following Sraffa 1925, 1926, 1960, with the addition in his works of technological progress; c) enucleating a rent in oligopoly, as in monopoly.

In section **3** the consequences are drawn as regards the regulatory assets. We show how the differences between oligopoly and monopoly are too weak to concentrate attention only on monopoly. Thus oligopoly also needs public intervention. This can take the fiscal form, through the tax differentiation on oligopoly rents.

Section **4** is dedicated to the conclusions. In the appendix the question of amortization is scrutinized , in situations such as “wear and tear” and technological progress.

2. The comparison among competition, monopoly and oligopoly

Firstly we go deeper into the question of the minimum average cost. This regards intermediate input and wages, and also amortisation. Then there are the rate of interest and entrepreneurial profit. We treat the problem from the point of view of a single sector, so the inputs prices are given. There is technological progress, so the

price of the product, given unit wage, decreases over time. We start with the following equation, valid for a situation of perfect competition, referred to the year **t**:

$$\mathbf{Qp = (1+\pi)[(1+r)(Lw + ap_a + bp_b + \ldots + hp_h) + D(Mp_m,\theta,\omega\tau(r))]} \qquad \mathbf{[1]}$$

The yearly production is **Q** and its price is **p**. The profit is **π,** which in competition is equal to the remuneration of top managers, or, in their absence, for small firms, to a percentage which, though maximized, is fixed and is roughly in a constant ratio with total costs (between squares in **[1]**). In fact entrepreneurs (or general managers) choose the target-functions, find the funds, check the intermediate inputs, manage the labour, decide about amortization[2]. The rate of interest is **r** (calculated at a yearly pace) and the business is totally indebted. In the case of own capital, its rate of return is equal to the rate of interest in competition (and therefore eventual differences between rate of profit and of interest must be calculated into profits, which are so modified with respect to book-keeping). The rate of interest in this context is given, but in the general model it derives from the confrontation between saving (which includes amortization) and investment (plus public deficit and balance of payment surplus). The labour employed is **L** and **w** is its average compensation. The wage **w** in this context is given (in the general model it depends on **r**), whilst **L** is chosen at the minimal cost, together with other inputs and the current cost of capital[3]. Then the

[2] In particular, at parity of other conditions, in competition there is osmosis between entrepreneurial work in small firms (essence of profits in competition) and dependent employment. This explains **π** as given, although it is fixed at the maximum level.

[3] See Vitaletti (2017a), pp.2, 7-9 and Vitaletti (2017b), pp.41-42 and 51-53. The fact that minimal costs are reached does not mean that work and capital reach a stable combination. In fact, work may increase, and in this case the distributive magnitudes influence the composition of supply, provided there is a component "wear and tear". This is always present, except if technological progress is dominant. Here lays a Sraffa's mistake. For Sraffa's other mistakes see footnote 6. The mistakes of

summation of inputs comes, each item (from **a** to **h**) with its cost-price. In this context the cost-price is given, and the quantity of input is chosen at its minimum, of course together with labour and capital. Finally there is depreciation **D**, which, as we clarify in the Appendix, shows an **n** depending on the initial disbursement $\mathbf{Mp_m}$, from the reduction of industrial cost, **θ**, and on the rate of interest which applies to wear and tear (**ωτ**). Amortisation is calculated at its minimum[4]. The expression $\mathbf{(Lw + ap_a + bp_b + \ldots + hp_h) + D(Mp_m, \theta, \omega\tau(r))}$ furnishes the industrial cost for the product, while **(1+π)(1+r)** furnishes the financial costs. All magnitudes are taken at their value at the times **t, t+1…t+n** ; i.e. the optimization is dynamic, in the full sense of the word.

The average cost is simply taken by dividing the quantity **Q** for each member inside the square parenthesis of expression **[1]**[5]. We have then:

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marginalism are in any case much worse. Starting from the **U** curve of the average cost, there are: the equilibrium of price in the ascending point of average cost, in which marginal cost touches the price; the absence among costs of a uniform rate of interest and of personal costs of entrepreneurship; the short run equilibrium, with the hypothesis of given capital (and, beyond that, as in Sraffa, there is no technological progress); no idea of the central role of amortisation, and of its dependence on the rate of interest and technological progress; the freedom between production (which is optimal independently from distribution of income) and distribution (which can be corrected); the theory of optimal taxation, which ignores the existence of public expenditure; the macroeconomic consequences of economic theory, which make the level of wages the main variable to adjust in presence of a unemployment crisis.

[4] As we shall see in the Appendix, the current cost of capital, as a whole, is a stable value. Thus, if there are costs variations (including that of labour) and/or the quantity produced reduces, there is a compensation in amortisation, which is lower. Thus the entire theory of the firm is restated.

[5] Especially with technological progress, we have also a series of prices for each year **t, t+1…t+n**. In each year the minimized costs as a whole are stable, i.e, they do not move with quantity. If they move with unit quantity by decreasing, we have as a consequence rents. This circumstance is examined later, and we find rents which are incompatible with a true competitiveness. If they move with the unit quantity by increasing, we have on the contrary rents by decreasing returns (cfr. Sraffa, 1960, Chapter XI), compatible with perfect competition. The 1925 Sraffa's article shows that unit costs in industry (when there is competition) are stable as a tendency, like all classical theory thought.

$$\mathbf{p = (1+\pi)[(1+r)(L/Q)w+(a/Q)p_a+(b/Q)p_b+\ldots+(h/Q)p_h + D(Mp_m,\theta, \omega\tau\,(r))/Q]} \quad \mathbf{[2]}$$

If this average cost is the same independently from the quantity **Q** we choose, we are in a Sraffian System. It is such a way in competition, except for a small treat at the beginning of quantities, where the unit cost decreases[6].

[6] In Vitaletti, 2017a, pp.38-80, and 2017b, the resulting minimal costs are treated simultaneously in a general equilibrium of Keynes' and Sraffa's type. Some characteristics of this equilibrium are:

a) the rate of interest is determined, as already said, by the equilibrium between Saving (including amortization) and Investment (plus balance of payment surplus and public deficit). This rate can be zero, or near zero. This is the Keynesian state, very similar to the actual;
b) the unit rate of wage is determined consequently, in a world without capital. This occurs because all outputs are equal to one, and inputs can be taken in physical terms with respect to the output, summing them vertically and then taking their mean;
c) the prices of all commodities which produce a unity of output follow. To reach absolute prices, we have only to multiply the resulting prices for quantities;
d) the switch of techniques is completely avoided when the ratios between input (taken vertically) and output are the same for all sectors; in the other cases it may happen through the change of input prices;
e) in a world with capital, the number of years of amortization, **n**, is determined too, and its amount in general depends positively on the interest rate. Since in the last year there are growing expenses which regard capital, or there is a reduction of the productivity, there is an intrinsic contradiction with the standard commodity;
f) a characteristic of the solution is that amortization reaches the minimum when its last amount is zero. Even with fixed capital the reduction to labour quantities is thus possible;
g) the technological progress may temporally precede the extra costs (or the reduction of productivity). In this case a determination of the relation between the rate of profit and of wage is possible independently from prices. This provided, for each rate of interest, wages increase;
h) we have a complete competitive model, which determines full employment and prices even with technical progress;
i) the circumstance that the whole economy is represented reinforces the strength of Sraffa's system.

The model is optimal from every point of view, and it is very distant from Marxian consequences, which are often advocated. The disturbances derive by Keynesian problems (which are more complex than it is believed); by oligopoly and monopoly (which are part of the categories of rents, nowadays very important though almost ignored); and by other factors (see footnote 12). Beyond these, which represent principally a criticism external to the Sraffa's system, the principal mistakes and omissions internal to the system are: a) the message about distribution is confusing – the **w** and **r** relation, in a world without capital, can be solved quite simpler than in Sraffa, independently from prices; b) the reduction to dated labour is possible even with capital; c) the technological process can be inserted without great problems, provided the wage **w** increases (we have only to calculate the modification of the average input-output ratio); d) there are some problems with multiple production, and in the case of rents (which include all the departures from the minimal average production cost, positive or negative), in which demand is necessary.

In oligopoly and monopoly things are different. In monopoly the question of demand is intrinsically decisive. In oligopoly there is competition, but this derives from the existing firms, market entrance being very limited; moreover costs (at the extreme, even production costs) decrease with the quantity, which makes the research very interesting[7].

In the first instance few words for natural monopoly. The expression [2] summarizes the price in competitiveness. Natural monopoly refers to what was described in footnote 1. There may be a natural situation which leads to a monopoly. So in local situations there is public transport; the management of waters; garbage collection and transport; the sewer system, and other services, which, for structural reasons, need to be managed by only one firm. At the national level, there may be the railway; or electricity, or energy which may impose a single firm management. In general in these cases there is a coordination which requires a single firm, which manages "the nets". The relative theory is treated by "the natural monopoly", which is a recognized part of public finance (see the next section). In summary, it is represented in footnote 1.

[7] No reference is made to the economic literature, which insists in presenting an equilibrium in which the price is established in the *crescent* treat of the curve of minimal cost. See for example Sharkley, W.W. (1982), Chapter 1. Even accepting the hypothesis that capital is given, the unit industrial costs are decreasing, since capital is usually in part idle and unit other industrial cost descend (see the last sentence of the Appendix in this work). Also in Carltron & Perloff (2000), the formulation is the same. They start in fact in Chapter 2 by showing the typical cost function. Then they go on this basis, by examining: the typical problems of structure and of conduct, i.e. the numbers of buyers and sellers; the barriers to entry of new firms (without presenting them as a consequence of increasing returns); the product differentiation; the vertical integration; the diversification; the advertising; the research and development; the pricing behaviour; the plant investment; the legal tactics; the product choice; the collusion; mergers and contracts. Only on commercial textbooks (see Fontana and Caroli, 2003) things are quite different. Entrance barriers are examined in depth (p.33-37); commercial expenses are fully treated (where they are almost absent in economists' texts); no increasing costs function appears.

The oligopoly situation instead is not treated by public finance textbooks, not even in their fiscal parts (at least explicitly). It may sometimes appear in political economy textbooks, under the chapters on anti-monopolistic regulation[8]. The different situations (one is oligopoly, which maintains competition; the other is monopoly, which excludes competition) are at the base of this differential treatment. But the competition is oligopolistic, and is profoundly different from free competition, which postulates the freedom of market entry, which is excluded in oligopoly.

Here the average industrial cost, after the rapid initial decrease, falls at a slow rate or remains stable. Most firms, if they manage to pass the accelerate decrease of unit cost, continue their activity. Especially if the sector is growing (due to increased demand and/or price decrease because of technological progress), single firms will show different produced quantities.

There will be a point where new firms can not enter the market. In fact the new entrants, at the beginning of activity, when their individual demand is low, will incur heavy losses. At that point the firms existing in the market will capitalize the circumstance, trying to increase their $\boldsymbol{\pi}$. For example, their profit may establish to $\boldsymbol{\pi' > \pi}$. At the end the following rule for prices establishes:

$$\mathbf{p' = p + (\pi' - \pi) ass Q_0} \qquad \mathbf{[3]}$$

where the **ass** stands for associated. Up to this point this is the only modification depicted into the Sraffa-Keynes model.

[8] It is so a main object of study of Political Economy. A clear example is the book by Motta and Polo (2010). Already in Chapter 1 of this book it is clear that the distinction is inside the competitiveness field, but it is not indicated the absence of freedom of entry in oligopoly, nor the fact that commercial costs are decreasing.

The element π in equation [1] and [2] is still unexplored. It supposes that a person gains from his activity, employing his capacities. But these capacities may be utilised for a different number of hours. By working longer hours, he can thus earn more. In this case output increases, with very little additional cost. There is a limited possibility that, in so doing, the price can be slightly reduced.

Beyond production in a material sense, we have to examine the pace of commercial costs. These are decreasing even at their base, which is given by the reduction of the price offered to bulk buyers. It is one of the reasons for the success of supermarkets, and the reason why many small dealers organize “buying associations”.

The big jump is however with the circumstance explained by “principal-agent” theory (i.e. one, or one group, dominates the business, even when it is large), which means the possibility of administration of big groups. Research&Development expenses may develop, in particular with the task of creating patents, or brands. A patent is a sort of monopoly, as a brand. The possess of patents and brands opens the possibility of a moderate price increase.

The fixation of the price in a “monopolistic” way follows. This opens the possibility of quantity reductions, which are minimised through various methods. One method is advertising, which stiffens the demand curve, and as a consequence minimises the quantity reduction due to price increases. A second method is the differentiation of the product, which can be more effective when the characteristics of the sales of a particular country are satisfied. A third is technical progress, which allows in any case strong reductions of prices, with increasing margins of profit.

Advertising, beyond stiffening the demand curve, has the characteristic of reducing its unit cost when output grows. We are encountering then a unit decreasing commercial costs.

The administrative expenses are another example. The transfer pricing, other ways to minimize the fiscal cost of the product, once obtained, work as a “permanent” gain, with possibility of declining of the price, the declining being major the greater quantity is sold.

The assistance expenses are another example, being their unitary impact minor, the greater is the quantity sold. Now, with new technologies, the possibility of producing in countries with a low cost of labour, and the possibility of saving taxes, firms behaviour comes near to monopoly.

Even the unit production costs is subject to this law, with the internalisation process. All costs tend to give now a “competitive” advantage to the firms with greater quantities.

Let us observe the optimizing choice, considering what has been written in footnote 1. The fixed, or almost fixed costs, are absorbed after a certain point by the quantity demanded (the quantity of *break even*, see Lupi, 2019, pp. 44-47). The *break even point* coincides with the expression **[2]**. Also Fontana and Caroli, 2003, p.132, treat this point without emphasis, as it were a normal fact in the description of firms characteristics.

Beyond $\mathbf{Q_0}$ in the **[2]** profits are growing with the quantity. The classic graph of every textbook of managerial economics is so confirmed. We have then:

$$\boldsymbol{\pi''} = f(\mathbf{Q}) \quad \text{after } \mathbf{Q_0} \qquad \textbf{[4]}$$

expression in which the price may stay up with respect to **p'** in **[3]** (when the importance of advertising, patents and brands dominates), or may stay down (if the minimization of production cost abroad and the fiscal avoidance dominate).

If the total quantity sold to the market tends to slow down, or stops (an example is now the car industry), the opportunity of making agreements, or fusions among big organisations come out. These have the intent to preserve extra profit margins, with **p** greater with respect to the expression **[2],** in the nearby of expression **[3]**.

If vice versa the market is in full expansion, the saving of taxes is effective, the reduction of industrial cost obtained through "administrative" ability (as transferring the production in the countries where the pay **w** is very low) is high, we can experience a sort of monopolistic situation, with enormous profits, with **p** minor with respect to the expression **[2]**[9].

3. Rules and taxes for monopoly and oligopoly

Let us start from competition, defining competition as freedom of entry in the market. Competition regards, with this definition, almost all the services sector, the handicraft and the agriculture, that is the majority of an advanced economy. One can

[9] As regards the reformulation of Sraffa's theory (see footnote 6), this is still valid for the service and the handicraft sectors, and even for the industrial sector, inasmuch it is dominated by the expression **[3]**. As regards the situations in which the prices comprehends a rent (agriculture, mines) this is enough valid, notwithstanding some corrections are necessary (see Vitaletti, 2014b). In the case the single sector is dominated by the situation depicted in equation **[4]**, we need a stronger reappraisal, since different economic system are confronted, in a situation in which total unit costs tend to decrease in relation to the minor **w** in the production countries.

open a bar, an hotel, a commercial activity, a handicraft, or engage in an agricultural activity, without many problems. So when profitability in one sector is high, it is likely the entrance of new firms. This does not mean that there are not problem. Except in agriculture, where the demand is infinitely elastic, in most sectors the demand curves of firms is negatively inclined, so they can be defined as working in "imperfect competition". By and large, nevertheless, we can assume that the freedom of entry is decisive. On other cases, we could have the situation of the competitive sector as a refugee for employment, when total unemployment is very high. This causes a reduction of unitary incomes in it. In any case this is an exceptional situation.

The other side with respect to competition is monopoly. Let us start from the classical monopoly of public services. This regards specifically the nets. Here, following Steve (1976, Chapter 8), we can have a situation with the minimum cost, but the intersection with the demand curve is in its descending treat and therefore meets the marginal cost when this is inferior to the average cost[10]. Following Sraffa (1926) instead, in equation **[1]** we have a situation in which the marginal cost equates the average cost. In this case the price is fixed where the elasticity of demand is equal to one. Public intervention tends to take form of nationalisation. The price may be fixed at every level: above the average cost (much above in the cases of games); equal to the average costs (in this case there is the problem of providing funds in

[10] Steve justifies this hypothesis with an excess of plant, which would be structural in public services. Leijonhufvud (1995, pp.68-73) insists in finding decreasing returns in capital management, ignoring the commercial, the finance and the administrative costs.

case of development); or inferior (if there are social benefits which derives from the sector). Things like the double price (one associated the marginal cost, one, fixed, associated to the average cost) (see Steve, Chapter 8), have not much sense.

In monopolistic situation there is the possibility that trade unions organize production in a way in which the "right of workers" prevails neatly on "the right of consumers". It is necessary in these cases try to contrast such organizations, for example by establishing that the pays are on line with similar sectors; by superintending with rigour the presence at work; by avoiding situations of privilege in the social welfare of these sectors.

In the end oligopoly comes. Here competition in textbooks is much stressed, but it refers mostly to the existing firms, inasmuch there is not freedom of entry. Once this is established, the relevant things are: a) a basic profit generally higher than normal; b) profits increasing with the produced quantity.

I think that if this problematic is worldwide, the solution must be worldwide[11]. We have to stop to try to impose national taxes on business, or we have to reduce them at the minimal level. On the contrary we should to implement a taxation at a worldwide level (now this means G20), which regards the excess level of profits (i.e, all the profits which remain after applying the rate of interest on all the activities of a firm), at a rate enough high (say, around 50%).

[11] This does not mean a worldwide fiscal system. At international level, beyond the intervention on oligopoly, there is only the need to impose a 100% rate (or in any case a very high rate) on the rate of interest of advanced countries, in order to allow a yearly deficit for them, necessary against unemployment (stated by "local" international agreements, like the EU). The new national system can be achieved by direct levies on the social expenditures beneficiaries (dependent and independent workers), and by indirect taxation (adding a small rate on B to B commerce to the actual Vat, and reinforcing the actual taxation of energy). See Vitaletti (2017a, 2017b**,** 2014a).

This is the only way to contrast the power of oligopolistic – monopolistic businesses, and to let the competitive economy (which is the greatest part of the economy) dominate.

4. Conclusions

In this paper we have compared, in the first instance, competition and monopoly at the national level, taking as a principal reference the 1925 and 1926 articles by Sraffa. Later we explored the situation of oligopoly, characterized firstly by internationalisation, in which decreasing costs (*latu sensu*) were considered.

As regards interventions, hardly any are necessary in a situation of competiveness. In monopoly a situation of public intervention is preferred, which fixes the prices (independently of old rules) at a level which may be higher, lower, or equal with respect to competiveness. Oligopoly leads to direct worldwide intervention (at G20 level), to try to reduce the excess profits (rents), which tend to form. The fiscal system is required, both directly (requiring an higher than normal rate) and indirectly (general support of the private services, handicraft and agriculture).

Appendix

The plants duration

The question of capital duration can be solved following Vitaletti's work (2008). In the absence of technical progress, the initial supposition is made that there are variations of costs (for example maintenance expenditures), the amount of which grows over the years. This essential supposition derives from the fact that in Sraffa's work (1960) the duration of capital is inexplicably given, at parity of effective costs over the years, and this hypothesis has been the cause of a serious default of the model (negative prices). It is shown, in particular, that when the initial value of investment $\mathbf{M_0p_m}$, multiplied by the interest rate, is equal to the total interest attributable to those additional costs (given by the total additional cost less the discounted compound rate for each year, applied to each part of the additional cost), the minimal cost of amortization is obtained and $\mathbf{M_0}$ is dismissed (Vitaletti, 2008, pp.132-135). Four methods to calculate the exact plant duration are then analyzed (Vitaletti, 2008, pp.139-142). From these methods the duration of the plant, **n**, is found to depend positively on the rate of interest. A generalisation of these results is provided (Vitaletti, 2008, pp.142-143), considering also the circumstance that not only costs may increase with the duration, but revenues may also fall, due to decreasing efficiency. At the end, amortisation, in a context of absence of technical progress (i.e. "wear and tear" amortisation), appears as "residual" cost, which

reintegrates the capital value at the minimal cost and the most efficient **n**, at the price coherent with the distributive magnitudes[12].

In the presence of technical progress the situation changes. Suppose that technical progress is such to reduce the minimal cost of capital in the second year of operations by $\mathbf{-(\theta_1 - 1)M_0p_m + M_0p_m(1 - \theta_1)r}$; in the period **i+1** by $\mathbf{-(\theta_1 - 1)M_0p_m + M_0p_m(1 - \theta_1)r}$; and so on, until the **n** period, in which the reduction is given by $\mathbf{-(\theta_n - \theta_{n-1})M_0p_m + M_0p_m(1 - \theta_{n-1})r}$. The product price, other things being unchanged, falls. This happens because in the same year there is competition with the new capital, which operates with the predicted minor costs, whilst the firm under observation maintains its **OC** unaltered. In term of a System based on equation **[1]**, as **[5]**, we would have:

1° Period	**OC**	**+**	$\mathbf{M_0p_m r}$	**=**	**pQ**
2° Period	$\mathbf{OC - (\theta_1 - 1)M_0p_m}$	**+**	$\mathbf{M_0p_m(1 - \theta_1)r}$	**=**	$\mathbf{(1 - j_1)pQ}$
	…….....…….. [5]				
n-2 Period	$\mathbf{OC - (\theta_{n-2} - \theta_{n-3})M_0p_m}$	**+**	$\mathbf{M_0p_m(1 - \theta_{n-3})r}$	**=**	$\mathbf{(1 - j_{n-3})pQ}$
n-1 Period	$\mathbf{OC - (\theta_{n-1} - \theta_{n-2})M_0p_m}$	**+**	$\mathbf{M_0p_m(1 - \theta_{n-2})r}$	**=**	$\mathbf{(1 - j_{n.2})pQ}$
n Period	$\mathbf{OC - (\theta_n - \theta_{n-1})M_0p_m}$	**+**	$\mathbf{M_0p_m(1 - \theta_{n-1})r}$	**=**	$\mathbf{(1 - j_{n-1})pQ}$

[12] Another problem caused by this circumstance is that, since amortization prevails in initial periods, whereas the increase of other expenses and/or the decline of productivity tend to prevail in the final periods, there is the convenience to use more intensively (in particular as regards shifts) the plants at the beginning of their operative lives. This happens because in such periods there is more "room" for wages extra-payments, caused by the shifts (see Marris, 1964). The technical problems mentioned in the final part of footnote 6 as a third factor of disturbances of the cycle (due to the erratic concentration of investments) could be a consequence. A planned underutilization of plants (one shift instead of two or three shifts) could be another consequence, save the fact that, when demand increases in the short run, the more profitable use of the plants is carried forth. Thus a rationale is found for the decreasing costs in the short run, as stated in the final sentence of this Appendix.

where the periods **1, 2…n** are successive to the initial Investment $\mathbf{M_0p_m}$; $\boldsymbol{\theta_1}$, $\boldsymbol{\theta_2}$ …. $\boldsymbol{\theta_n}$ are all greater than one, and each successive term is greater than its predecessors (at the maximum it is equal). At the left of the System **[4]**, beyond **OC**, which represents the other financial and industrial costs (taken at their minimum) with respect to amortization-depreciation, there is the value of capital, and the interest paid on residual capital. It is a particular process of amortisation-depreciation, which assumes (as it *should be*) that the capital which depreciates due to the technological progress, linked to $\boldsymbol{\theta_i}$, is given back to the bank which has lent the entire capital $\mathbf{M_0p_m}$. Consequently interests decrease for that year (and in other years in which there is depreciation). At the period in which $\boldsymbol{\theta_n}$ is equal to **1**, also the capital is entirely devalued; in the period **n+1** it would appear **OC = (1 - j)pQ** The length of the giving back depends negatively from the pace of technological progress. The more intense this is, the greater $\boldsymbol{\theta_i}$ is, and minor the length. In particular $\boldsymbol{\theta_i}$ is linked also to the symbol $\mathbf{j_i}$ **(**which appears to the right of System **[5]** multiplying **pQ**), after its subtraction by **1**. Taking as an example the period $\mathbf{j_i}$, we have:

$$\mathbf{OC - (\theta_i - \theta_{i-1})M_0p_m + M_0p_m(1 - \theta_i)\,r = (1 - j_i)pQ} \qquad \mathbf{[6]}$$

where technological progress determines $\boldsymbol{\theta_i}$, $\boldsymbol{\theta_{i-1}}$ and, in a way to accept the equality just outlined, also $\mathbf{j_i}$. In particular, from **[6]** can be derived the relation **[7]**:

$$\mathbf{j_i = 1 - OC/pQ} + \mathbf{[(\theta_i - \theta_{i-1}) + (1 - \theta_i)\,r]M_0p_m/pQ} \qquad \mathbf{[7]}$$

which links specifically $\mathbf{j_i}$, $\boldsymbol{\theta_i}$ and $\boldsymbol{\theta_{i-1}}$. This means that $\mathbf{j_i}$ is structurally linked to one minus the ratio between other costs and revenue, plus a variable part, depending on the new devaluation in period **i** minus the fewer interests caused by it, all divided by

the revenue. The devaluation of the capital depends exactly on the entrance in the competitive market of new firms, which at the beginning of their activity are able to produce the same output **Q** with a minor unit cost.

If the dismissing of capital $\mathbf{M_0p_m}$ occurs when the cost variations previously discussed have already come about, there is the negative impact due to this factor. This variation will imply in fact the maturation of some "real" amortization, which is to be summed up with the depreciations due to technical progress.

Only when technical progress is so elevated to render null the variations of costs (including labour) and the reduction of quantities (in the sense that they come later with respect to the time when depreciation has annulled the value of the capital), the process can be entirely described in terms of depreciation. When there is even a small variation of costs and/or reduction of quantities, amortization comes about.

It can be noted that capital normally is acquired in a larger amount with respect to normal necessities, and/or it is used less than profitable, for the possibility that it could be useful in the case of a greater demand. If demand is greater than foreseen, therefore, the capital cost decreases.

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