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Are we at the beginning of a new long term expansion induced by technological change?

Angelo Reati*

Internal Paper

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

Referring, as a general background, to the long waves theory, the paper shows that Western economies now seem to be in the recovery phase of the long stagnation which started in 1974 and that, probably, a new long wave will begin in this decade.

The main factor justifying this hypothesis is the technological revolution in computer and information technologies initiated in the Seventies, which reproduces the long waves mechanism.

Two other elements corroborate the above assessment on the long term prospects :

i) the recovery in profitability at the beginning of the eighties, an evolution that usually characterizes the recovery phase of the long stagnation;

ii) the unusual length of the prosperity phase of the business cycle in the eighties. Of course, this aspect plays a subsidiary role with respect to the two others mentioned above. However, taken in conjunction with them, it reinforces the opinion that underlying recent favourable performances, there is a change in the long term trend.

INTRODUCTION

Since 1982 the business cycle in the Community has been expansionary. From 1974 to 1982, the EUR-12 GDP and industrial production average growth rate at constant prices was 1.9% and 0.8% per year, while from 1982 to 1990 the growth of GDP and of industrial production was 2.7% per year. Similarly, gross investment, which declined at the average rate of 0.2% per year from 1974 to 1982, increased by 4.0% per year from 1982 to 1990. Recent years have also contributed to a slight reduction in the unemployment rate (9% in 1989 as against 10-11% in the second half of the Eighties) and to a small increase in employment (1.4% per year from 1986 to 1989).

The question thus raises whether this expansion is purely short term or whether it is the second phase of the long term stagnation (the recovery) which started in 1974. Were the answer positive, a new long term expansion could start in the present decade. The diagnosis of how the present situation will evolve has profound implications for economic policy. If the present recovery is not just a short term phenomenon, the conventional approach of demand and supply management is no longer relevant, and the main focus of Community and national actions will instead be on technological change, industrial policy and the institutional and social changes required to implement the new regime of accumulation.

The analysis will be conducted within the theoretical framework of long waves (Van Duijn 1983). Although still controversial, the recent empirical work on the existence of long waves in production and innovations have made this approach sound enough to be taken as a background for the present investigation.

In part I of this paper I shall present a brief summary of the long wave theory, focussing on the effects of technological change. Part II will present the factors justifying the argument that a new long wave will probably begin

in the nineties. They are: the technological revolution in computer and information technology, the recovery in profitability and the different behaviour of the business cycle.

PART I

THE LESSONS FROM THE PAST : EMPIRICAL EVIDENCE AND THEORIES

The results of researches on long waves in output[1] can be summarized as follows :

a) the long term evolution of the industrialized capitalist economies has followed a quasi-cyclical pattern (wave) of 50-60 years;

b) one of the fundamental causes of the long upswing is a "technological revolution", which presents these characteristics:
   - radical innovations do not appear at random but show a precise time pattern, correlated with the economic long waves;
   - innovations cluster;
   - the radical innovations which materialize first are process and product innovations in existing industries; they are followed by product innovations giving rise to entirely new industries;

c) to be successful, technological revolutions require profound institutional changes;

d) the rate of profit plays an important role in the long wave mechanism;

e) the business cycle behaves differently according to the phases of the long wave.

I. The long waves : a real phenomenon ?

1. The statistical data of developed countries show a quite regular recurrence of 25-30 year periods of sustained growth followed by periods of stagnation of the same duration. Since the industrial revolution, these fluctuations have produced four long wages (table 1) (see Van Duijn, 1983 : 143 and 155; 1984. This author takes into account the results of other scholars).

Each long wave develops in four phases:

. prosperity, in which growth is high;

. recession, in which growth decelerates;

. depression, in which growth is near zero or even negative;

. recovery, in which the growth rate is modest.

According to Van Duijn (1983), prosperity and recession form the long expansion while depression and recovery belong to the long stagnation.

2. However, the existence of long waves in "real" variables is contested, particularly for the first long wave[2]. For instance, taking data for the UK, France, Germany and the U.S.A., Solomou (1987) and Van Ewijk (1982) reject the hypothesis of a 50 year cycle in GDP or industrial production[3].

Note that empirical testing of long waves is a tricky question. Quite often, scholars use spectral analysis (e.g. Van Ewijk, 1982), a method specially devised to study cyclical movements. However, when applied to long waves, this method presents serious drawbacks because: a) the statistical series are not sufficiently long, since they cover a maximum of four waves; b) they do not meet the demands of a stationary series and the elimination of the trend can affect the identification of peaks[4]; c) this method implies a regularity of cycles that does not actually happen and that, moreover, is not indispensable in order to confirm the occurrence of long waves. For these reasons, Van Duijn concludes that "spectral analysis cannot prove or disprove the existence of long waves". (Van Duijn 1983 : 172).

TABLE 1 : The long wave chronology (1)

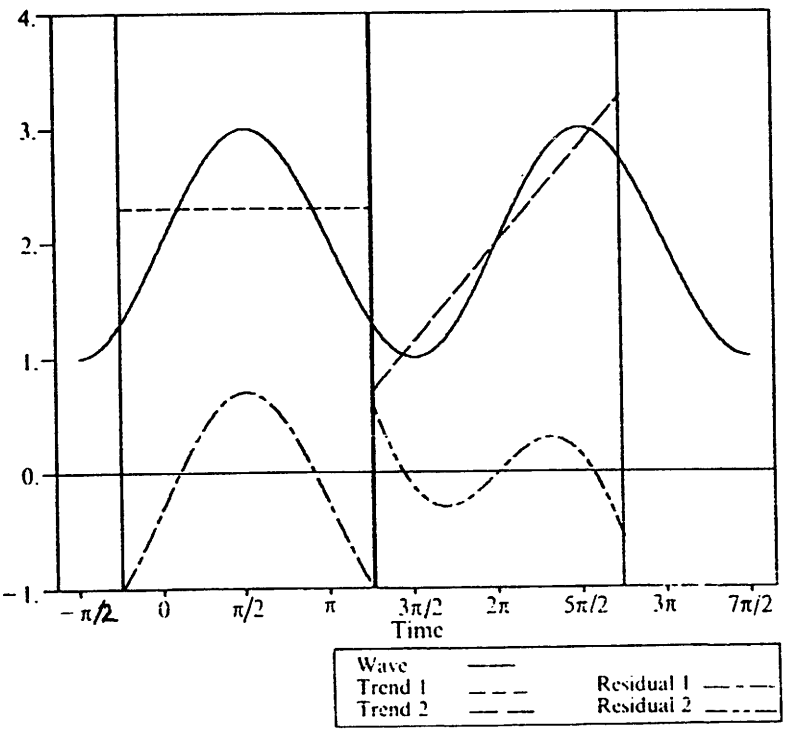
I. 1782-1845		
A) expansion	1782-1802	- prosperity
	(war 1802-1815)	
	1815-1825	- recession
B) stagnation	1825-1836	- depression
	1836-1845	- recovery
II. 1845-1892		
A) expansion	1845-1866	- prosperity
	1866-1872	- recession
B) stagnation	1872-1883	- depression
	1883-1892	- recovery
III. 1892-1948		
A) expansion	1892-1913	- prosperity
	(war 1914-1918)	
	1920-1929	- recession
B) stagnation	1929-1937	- depression
	(war 1939-1945)	
	1937-1948	- recovery
IV. 1948-(1995 ?)		
A) expansion	1948-1966	- prosperity
	1966-1973	- recession
B) stagnation	1973-1982	- depression
	1982-...(1995?)	- recovery

(1) This periodization is taken from Van Duijn (1983 : 143 and 155). According to Van Duijn (1984), the depression phase of the fourth long wave ended in 1982.

This is just an example of the more general problem that the statistical method adopted is not neutral with respect to the results we obtain. I am referring here to the "Slutsky effect" (Slutsky 1937) and to the "perspectivistic

distortion" (Reijnders 1990). As Slutsky demonstrated, the smoothing procedure can, in fact, generate cycles of different length which are not embedded in the original series. The "perspectivistic distortion" depends on the time span of the statistical investigation (the "window"): a large "window" will emphasize the long cycles while a narrow "window" does the opposite. This is illustrated in figure 1. Starting from a strictly periodic time series (with a period of 2π), a linear trend is fitted in order to derive the cycle. It appears that the apparent duration of this cycle is dependent on the length of the interval (the "window") and of its location relative to the series. Thus, with a "window" having a length of 2π we obtain the cycle of the left-hand side of fig. 1; with a shorter "window", in which the length concides with one of the points of inflection of the original data, the resulting cycle is depicted in the right-hand side of figure 1.

FIGURE 1 : Illustration of perspectivistic distortion
(Reijnders 1990, p. 137)



However, W. Stier has recently proposed a new filtering technique that should avoid these two ambushes and, as we will now see, this allows for more positive results on the existence of long waves.

3. Using a new methodology, Bieshaar and Kleinknecht (1984), Gerster (1988), Metz (1992) and Thompson (1990) provided evidence in favour of the long waves hypothesis. Using a technique similar to the "spline" regression (cf. Poirier 1976), Bieshaar and Kleinknecht studied 11 series of GDP and industrial production in seven core countries as well as for the world aggregate to establish whether they follow the periodization of table 1 above. The results confirm the existence of long waves after 1890, except for the UK.

Metz and Gerster made further methodological progress by adopting Stier's filtering technique to detrend data. Metz (1992) took the same series as Bieshaar and Kleinknecht, but he substituted the data for the two world wars (considered as a statistical disturbance) by linear interpolation. He obtained clear and conclusive evidence not only for the existence of the third and fourth long waves, but also for the first and the second. However, the first two long waves seem to have a different periodization than that shown in table 1: the first wave ends in 1820 (instead of 1845) and the second in 1885 (a date near to 1892, as reported in table 1), with a peak in 1860.

Investigating a larger sample (130 price and production series for 16 countries), Gerster reached results that are similar to those of Metz. However, unlike this author, in the majority of cases Gerster found cycles of 30-40 years, shorter than long waves. According to Metz, these discrepancies are explained bu the different treatment of world wars (Gerster does not eliminate these disturbing influences) and different definitions of possible cyclicity.

The idea behind the evidence provided by Thompson (1990) is that long waves materialize first in a small number of leading sectors (those created by the technological revolution; see paragraph 2 below), in a leading economy (UK until 1890 and USA from 1890 to present). Aggregating data on physical

(3)

production of ten leading sectors from 1760 to 1985, Thompson compares the long waves of the leading sectors growth rates to the conventional Schumpeterian periodisation (as revised by Kuznets and Van Duijn). He obtains two main results. First of all, there is a good match between the Schumpeterian long waves and the waves of the leading sectors in the leading economies (Thompson 1990 : 222). Second, there is also close correspondence between the long wave in British-American leading sectors production and British-American industrial production (id. : 223). This bears out the assumption that leading sectors are one of the principal engines of economic growth.

Even if the final word has not yet been pronounced, it is reasonable to conclude that "today more skepticism is needed to disbelieve in long waves than faith to believe in them" (Screpanti 1984 : 519).

II. Explanation in terms of technological revolutions

1. The Schumpeterian explanation of long waves as a result of a technological revolution seems the most interesting (Schumpeter 1977). This theory has recently been taken up by a number of scholars (Mensch 1979, Van Duijn 1983, Kleinknecht 1987, Freeman and the SPRU group, Mandel 1980, who incorporates it into a broader synthesis) and has also found empirical support.

Economic history shows, in fact, that each long wave is rooted in a radical breakthrough in technology which has pervasive effects throughout the economy. The new "technological paradigm"(5) resulting from this technological revolution makes all existing plant and equipment obsolete, requiring massive investment to replace them. This initial impetus to economic activity and its multiplier effect provide the basis for the upswing in output.

The first long wave was induced by early mechanization (the industrial

revolution); the second one by steam power and the railway; the third long wave resulted from electrical and heavy engineering and the fourth from the Fordist mass production. It will be seen later that the fifth long wave will probably result from computer and information technologies.

2. The technological revolution presents the following characteristics(6):

a) it brings with it many clusters of radical and incremental innovations in related fields(7). This bunch of innovations - which directly or indirectly are generated by the first technological revolution and help to implement it - further sustain economic activity by the investment it requires;

b) it relies on the availability of a particular input (or set of inputs) which is the key factor of the new technological paradigm. It is supplied at low and falling relative cost in almost unlimited quantities over long periods and has a potential for use in many products and processes throughout the economic system. These particular inputs were, respectively: cotton and pig iron in the first long wave; coal and transport in the second; steel in the third and oil in the fourth.

There is no unanimity among scholars on the way in which the technological revolution imposes itself. For some (Van Duijn, Kleinknecht, Mandel) it is through discontinuous waves of innovation; for Freeman (1982) the new technological paradigm emerges gradually within the old, showing its decisive advantages during the stagnation phase of the previous long wave.

3. Van Duijn (1983) shows that, during the depression phase of the long wave, the major innovations tend to appear in the existing industries and they concern the process as well as the product. During the recovery, the number of major process innovations in existing industries falls radically, while the flow of product innovations continues. However, the dominant feature of this phase is the appearance of radical product innovations which create new industries. The propensity to innovate therefore seems to change in

accordance with the schema of Table 2.

TABLE 2 : The propensity to innovate during the phases of the long wave
(Van Duijn 1983 : 137)

Type of innovation	Stagnation		Expansion	
	Depression	Recovery	Prosperity	Recession
Product innovation (new industries)	*	****	**	*
Product innovation (existing industries)	***	***	*	*
Process innovations (existing industries)	***	*	**	**
Process innovations (basic sectors)	*	**	***	**

The more stars the greater the propensity to innovate.

4. At first sight, it appears paradoxical that the wave of radical innovations starts during the depression, just when the rate of profit is at its lowest level and the outlook for demand is gloomy. Mensch (1979) gives a reply noting that when depression reaches its deepest point and enterprises have a very poor (or even negative) profit- ability, they are faced with a choice: either they innovate, bringing the rate of profit to a normal level or they disappear[8]. Innovations overcome depression.

Kleinknecht (1987) completes the argument with the observation that, during the expansion, two contradictory factors come into play. On the one hand, favourable prospects could encourage innovation. On the other, as long as the established lines of production are running well, firms have no incentive to bring out radically new products and find it more profitable to concentrate innovation and R&D efforts on gradual improvements within those lines. In this situation, the aversion to radical change is reinforced by the fact that new technologies often represent an uncomfortable substitution giving rise to competition with existing technologies and industries. This explains why,

when the first wave of radical innovations is fully implemented, there is no other one to take over.

How an economy moves out of this period depends on the intensity of risks and incentives: a prolonged depression with market saturation and overcapacities for established products may force firms to find new ways of creating a new technological paradigm.

5. For Mandel (1976;1980) also, the technological revolution is fundamental in explaining the long waves, although he places this factor in a broader synthesis which is worth mentioning.

The rate of profit is the gravitational centre of Mandel's analysis: a long waves theory is necessarily a theory of the accumulation of capital, and the relationship between the latter and the rate of profit is very close (Mandel 1980 : 9). The massive implementation of radical innovations is in fact possible on two conditions: 1) an exceptional long term increase in the actual and expected average rate of profit; 2) a long term expansion of demand.

The first condition depends on some exogenous factors and this results in the non-automatic characters of long waves. They are:

- a sudden and large decrease in the "organic composition of capital"[9] by a massive penetration of capital in sectors or regions where this composition is low, or by a decrease of prices for fixed capital and raw materials;
- an exceptional increase in the rate of surplus value[10], resulting, for instance, from a radical defeat of the working class or from an increase in work intensity;
- a sharp reduction in the rate of turnover of circulating capital (Mandel 1976, t. I : 224-225).

The long term expansion of demand results from the rapid pace of capital accumulation induced by the increase in profitability as well as by an appreciable increase in real wages. This wage increase is compatible with

profit's growth in that it does not exceed productivity gains.

However, the factors which have determined the long expansion tend to turn into the opposite. The generalisation of the technological revolution has many detrimental effects on profits, since the organic composition of capital increases, technological rents vanish and productivity growth levels off. This decrease in profitability is accentuated still more by an increase in prices of raw materials, the absorption of actual and potential excess labour supply as well as stronger worker resistance to new labour processes. In these circumstances, wage increases necessarily lead to a fall in profitability; at the same time social conflicts and competition between enterprises become more acute(11). The falling rate of profit breaks the pace of capital accumulation. Unlike expansion - that, as already noted, essentially depends on exogenous factors - the transition to stagnation is thus endogenous.

Referring to the third and fourth long waves, Mandel (1980 : 32-33) also shows that international economic relations are characterized by the presence of a hegemonic country and a stable monetary system during the long expansion while, during the stagnation, there is monetary instability and an erosion of the dominant power.

6. Mensch (1979) and Van Duijn (1983) were among the first to make a systematic empirical test of the Schumpeterian theory of long waves produced by radical technological changes. Mensch's analysis was deepened by Marchetti (1980; 1988). All obtained evidence favourable to the long wave approach. Their results were nevertheless challenged by Solomou (1986); recently, Kleinknecht (1990) provided new evidence which neutralizes Solomou's objections

a) Mensch studied a sample of 127 basic innovations from 1740 to 1960 (Mensch 1979 : 124-129)(12); grouping them by decades one can see clear peaks in the frequency of innovations during the depression periods.

Mensch's statistical procedure was severely criticized by Clark et al.

(1981) on the grounds that he unjustifiably omitted a number of basic innovations and inventions and that there is a high degree of ambiguity on the dating of some invention and innovations. However, the revised estimate made by Clark *et al.* did not invalidate the finding that innovations bunch but rather the fact that this becomes apparent during the depression (see also point c below)

b) Mensch's sample was further analysed by Marchetti (1980), who obtained some other interesting results. The first one is just an alternative way of presenting Mensch's findings: Marchetti shows, in fact, that in each long wave, the number of basic innovations follow a logistic curve. The second result concerns the inventions which precede the innovations of the sample. It is usually thought that inventions do not follow a particular time pattern. On the contrary, Marchetti discovers that inventions are also organized in clusters which can be analysed logistically. The only difference with respect to innovations is that the slope of the two logistics is not the same.

Marchetti deepens his analysis by calculating, for each long wave, the innovation and invention midpoints, i.e. the dates when 50% of innovations or inventions were in existence, as well as the innovation and invention "time constant", defined as the number of years taken for innovations (inventions) to increase from 10% to 90% of their maximum level. His results are reported in table 3. Several interesting features emerge.

Table 3 : Invention and innovation cycles
(Marchetti 1980 : 272)

	Long waves			
	First	Second	Third	Fourth
1. Innovation midpoints	1828	1880	1937	(1992)
2. Invention midpoints	1775	1833	1905	(1968)
3. Cycle centres	1802	1857	1921	(1980)
4. Δt between cycles centres	55	64	(59)	
5. Δt between invention and innovation midpoints	52	47	33	(24)
6. Innovation time constant	47	33	23	(16)
7. Invention time constant	120	85	55	(38)
8. Δt between innovation midpoints	53	57	55	
9. Δt between invention midpoints	58	72	63	
10. Saturation of market for primary energies	± 1800	± 1860	± 1921	± 1980
	(wood, US)	(hay, US*)	(coal, world)	(oil, world)

Innovation (invention) midpoints = dates when 50% of total innovations (inventions) of the long wave were in existence
Cycle centre = year at halfway between the invention and the innovation midpoints of the long wave
Innovation (invention) time constant = years required for innovations (inventions) to pass from 10% to 90% of their maximum level; Δt = number of years
Figures in brackets are projections
* primary source of energy for draught animals (pre-steam mechanical power)

First, the distance between the midpoints of the cycles corresponds closely to the conventional duration of long waves (4th row of Table 3). Second, there is a sharp acceleration in both innovation and inventions. It appears in fact from Table 3 that the average time lag between inventions and innovations diminishes sharply (5th row of Table 3) and that innovation takes less time to bunch (6th row)[13]. Curiously, the innovation time constant of one wave coincides almost perfectly with the time lag between invention and innovation in the following wave (see 5th and 6th row of Table 3).

Furthermore, the introduction of new primary energy sources seems in tune with the innovation waves, with the saturation of the market for primary energy coinciding with the midpoint of the cycles (10th and 3rd row of Table 3).

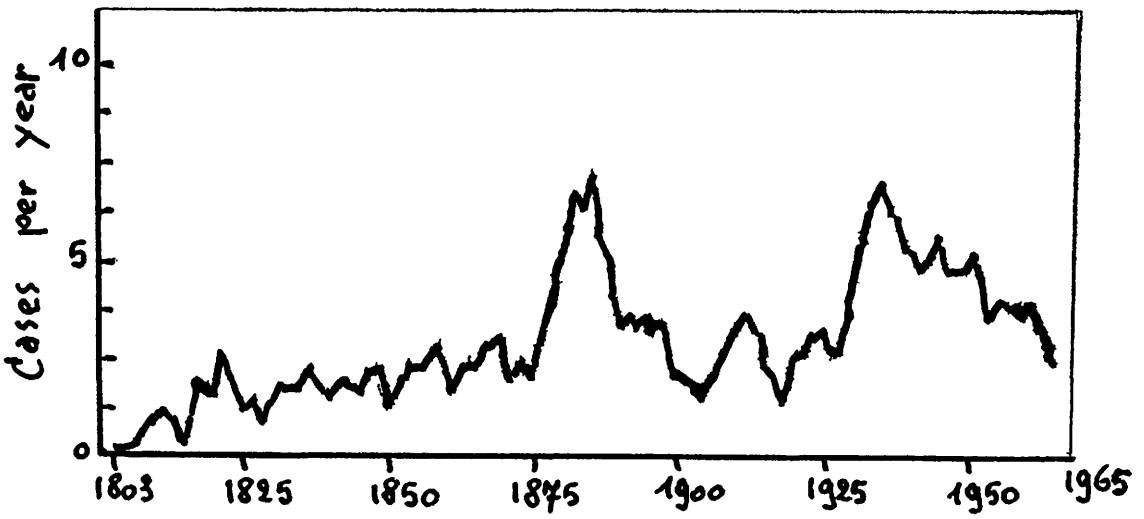
c) Van Duijn rectified some of Mensch's conclusions by analysing a larger sample of innovations, encompassing 160 major innovations introduced during the 19th and 20th centuries (Van Duijn 1983 : 174-179). It appears that, in the first and second long waves, innovations were more abundant during the recovery phase (the decades 1836-1845 and 1883-1892) while, in the third long wave (1892-1948), the cluster of innovations appeared during the depression of the thirties. In the present long wave innovations seem to be concentrated in the first part of the prosperity phase (1948-1957). These results, statistically significant(14), induce Van Duijn to reject the existence of a depression triggering effect (id. : 181).

d) Solomou (1986) challenges Mensch's conclusions more radically. In fact, relying on Mensch and Van Duijn's data and applying similar statistical tests, he infers that there are no regular clusters of innovations during the depression phases. In his view, radical innovations appear at random: "structural changes in the twentieth century have been confused with long waves" (Solomou 1986 : 111)(15).

e) More recently, Kleinknecht (1987 and 1990) provided new empirical evidence which conclusively rejects the core of Solomou's criticism. In fact, analysing a larger sample of "radical innovations"(16) from the beginning of the nineteenth century to 1968, Kleinknecht reached the conclusion that Solomou's criticism is plausible only for the early period of capitalism (i.e. until the first half of the nineteenth century). From 1860 until now the evidence shows a clustering of radical innovations towards the end of the

depression phase and at the beginning of the expansion. Thus, the period 1881 to 1901 was characterized by a strong performance in terms of radical innovations and the same happened for the period 1927 to 1962 (see figure 2, which is slightly simplified with respect to Kleinknecht's original one).

FIGURE 2 : Frequency of basic innovations
(seven-year moving average)
[Kleinknecht 1990 : 84]



The scheme is the following (Kleinknecht 1990 : 83), where "+++" means upswing and "---" downswings[17].

economic wave : 1873 --- 1893 +++ 1913 --- 1939 +++ 1974 --- ...
innovation wave :
12 years lead 1861 --- 1881 +++ 1901 --- 1927 +++ 1962 --- ...
15 years lead 1858 --- 1878 +++ 1898 --- 1924 +++ 1959 --- ...

III. A complementary approach: the role of institutions

1. It is widely accepted that the technological revolution that will eventually generate the long upswing cannot be implemented without profound social, organizational and institutional changes. For instance, Freeman and Perez emphasize that at the roots of each long wave there is a new techno-economic paradigm, something wider than the mere technological paradigm. They observe that "the onset of prolonged recessionary trends indicate the increasing degree of mismatch between the techno-economic sub-system and the old socio-institutional framework. It shows the need for a full-scale reaccommodation of social behaviour and institutions to suit the requirements and the potential of a shift which has already taken place to a considerable extent in some areas of the techno-economic sphere. This reaccommodation occurs as a result of a process of political search, experimentation and adaptation, but when it has been achieved, by a variety of social and political changes at the national and international level, the resulting good 'match' facilitates the upswing phase of the long wave. A climate of confidence for a surge of new investment is created through an appropriate combination of regulatory mechanisms which foster the full deployment of the new paradigm". (Freeman and Perez 1988 : 59)[18].

The crucial role of institutions (broadly defined) was systematically incorporated in a model of long term development of capitalist economies with the French theory of "regulation" (see Boyer 1986, De Vroey, 1984-85 and Jessop 1990 for a survey) and its equivalent in the U.S.A, the "Social Structure of Accumulation" (Bowles, Gordon and Weisskopf 1984; 1986). While the latter was devised to enrich the conventional explanation of long waves, the former developed independently and in a competing way from the long waves approach. However, long waves and regulation seem complementary rather than rival theories and it would be very useful to try to construct a synthesis of the two (Reati and Roland 1988).

2. The regulation theory (Aglietta 1976; Boyer and Mistral 1983; Lipietz 1979) studies long term structural change from a systemic viewpoint, considering the mechanisms which help to reproduce the basic social relationships of a sytem of historically determined institutional forms[19]. Institutions thus include not only the forms of state intervention and monetary and credit relationships but also the wage-labour nexus, forms of competition and the mode of accession to the international system. The interdependence of the productive organization and the consumption norm (or mode of consumption) is also emphasized.

The starting point for the regulation theory is similar to that of the long waves theory : a radical technical change (the assembly-line at the beginning of this century; automation and "Fordist" mass production in the fourth long wave) which, however, is not viable without a corresponding change in consumption. Mass production must go hand in hand with mass consumption, and the latter must grow steadily. It is then crucially important to have a wage bargaining procedure which allows a parallel and foreseeable growth of real wage and productivity. Social consensus is also essential. Social security (the "indirect wage") makes it much easier to attain this consensus and the scope increases for State intervention to facilitate capital accumulation. The long expansion is thus made possible by an "efficient" mode of regulation[20].

According to the regulation theory, post-1945 growth was associated with a regime of intensive accumulation ("Fordism") with mass consumption; from the second half of the 19th century until the first world war, capitalism was characterized by extensive accumulation and, during the 1920s and 1930s, there was intensive accumulation without mass consumption ("Taylorism").

With the extensive accumulation regime the consumer goods sector is rather underdeveloped, wage goods being largely provided by the family with the result that the demand directed to the market is limited. By contrast, the intensive accumulation regime with mass consumption is based on the parallel growth of the capital goods and consumer goods sectors. The supply and

demand for consumer goods are transformed: wage goods are produced using mass production techniques and the volume and composition of demand adapt accordingly. Wage goods are now entirely bought on the market.

A "structural crisis" like that of the Seventies and Eighties occurs when the functioning of regulation conflicts with existing institutional forms, which then have to be abandoned or bypassed. The contradictions which have undermined the mode of regulation during the last two decades were, first, the slowdown in productivity growth which eroded the basis of mass consumption and, second, public finance deficits which called into question the welfare state, a fundamental piece of social consensus. The institutions for collective bargaining were no longer effective, inflation became a "toxic drug", profitability deteriorated, the established hierarchy among nations was upset, etc. Economic crises manifest themselves as crises of regulation.

Long stagnation will end when the system succeeds in adopting a new accumulation regime, entirely different from the previous one, and in finding an appropriate mode of regulation. As in the case of long waves, the outcome is always uncertain, since transition to a new mode of regulation cannot be guaranteed in advance.

3. For the "Social Structure of Accumulation" theorists, long upswings depend on a periodically reconstructed set of institutions (the "Social Structure of Accumulation") which provides the economic, social and political stability required for favourable profit expectations and therefore for rapid capital accumulation. Radical changes in the institutional framework are thus the necessary conditions for a technological revolution and the ensuing long upswing.

The erosion of these institutions sets the stage for economic crises: business cycles are unable to restore the high growth trend of the previous phase.

Bowles, Gordon and Weisskopf (1986) and Gordon (1989) provided

empirical evidence for their theory considering the postwar U.S. economy. For this purpose, they devised some statistical proxies of the institutional features which prevailed in that period, such as: "the capital-labour accord", the "pax americana" and "the capital-citizen accord". Adding these variables to the variables reflecting technology and capacity utilization they obtained a more adequate econometric account of productivity, profitability and investment behaviour.

IV. Some other features of long waves

Two other elements of long waves are important in order to understand the present situation: the evolution of profitability and the behaviour of the business cycle.

1. With regard to the rate of profit, the fundamental question is to know whether the level and evolution of profitability are a cause or an effect of the long waves in production(21). Whereas, for the upper turning point of the wave, we can easily admit that the decline in profitability is one of the main causes of the transition to stagnation, things are less clear for the upswing.

There are three conflicting interpretations. According to Mandel (1980), for a new phase of long term growth to start, an exceptional and stable increase in profitability must first take place. Mensch also considers that the rate of profit is the cause of the technological revolution and the upswing, but for differents reasons. Firms introduce radical innovations not because the rate of profit is high but because it is extremely low and depression is at its deepest point. The other Schumpeterians (e.g. Van Duijn) believe that the evolution of profitability is the effect of the long wave movement : the technological revolution comes first; it induces expansion and, with expansion, profitability increases.

It is not possible, from the available evidence on the long term dynamic of the rate of profit (Shaikh 1989; Duménil, Glick, Rangel, 1987; Poletayev 1992), to settle the question conclusively. However, for the purpose of this paper, it is not necessary to establish exactly the direction taken by causality. It is merely enough to know the broad evolution of profitability during the phases of the long wave movement, particularly during the recovery.

The above mentioned studies show what follows (Fig. 3) :

a) long stagnation is characterized by three separate movements in the rate of profit :

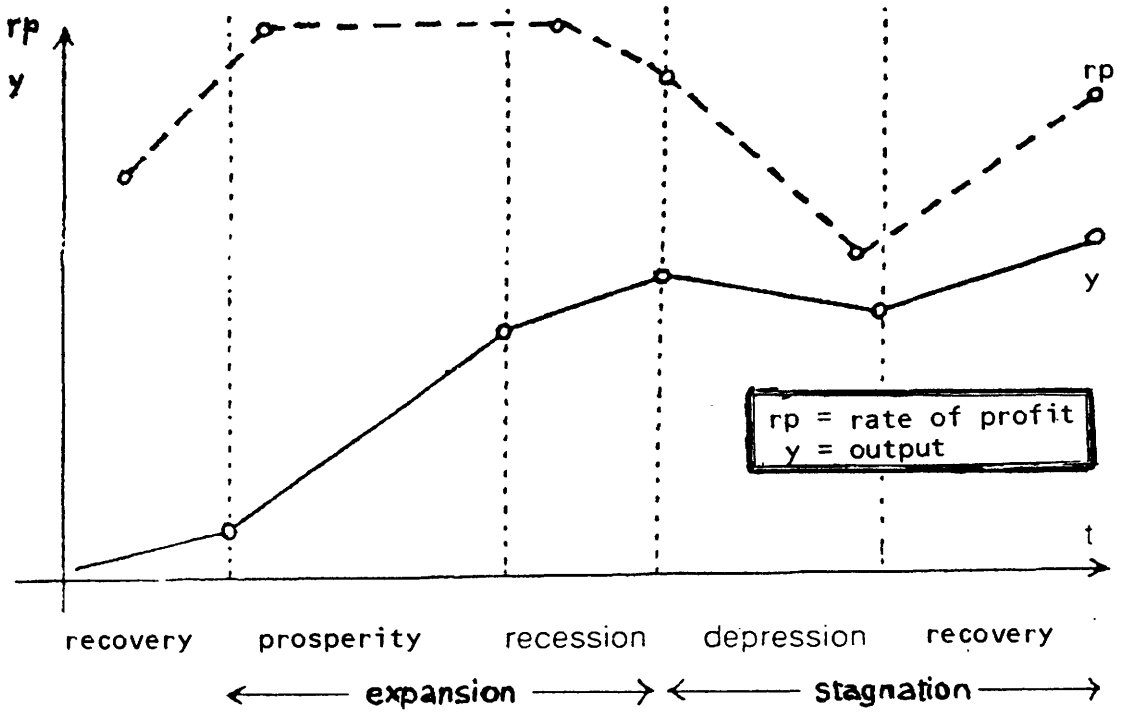
- firstly, a very strong decline during the depression, pushing profitability to its lowest level;
- towards the end of the depression, profitability starts to recover, under the "curative" effect of the business cycle. The weakest enterprises go out of business, those who survive restructure and, in this way, the profitability of the sector improves;
- this upward trend continues and accelerates during the recovery. As noted above, it is not yet clear whether this is the result of the technological revolution or rather the outcome of some exogenous factor;

b) during the long expansion profitability develops in stages :

- during the prosperity profitability usually stays at high and even using levels;
- during the recession the rate of profit starts to fall and this produces the turning point in the production trend : thus the effects of one of the factors underpinning the expansion are exhausted. There are many causes of this decline in profitability : social conflicts and excessive wage increases, an overaccumulation of capital in relation to profit opportunities, a decline in productivity growth, tight labour markets favouring wage increases, etc.[22]

FIGURE 3 : The rate of profit in the long wave

(Reati, 1990 : 23)



2. The long wave movement moulds the shape of the business cycle. In fact, during the long expansion the prosperity phase of the business cycle tends to be long and/or more accentuated and the recession short and/or less intensive[23]. During the long upswing, the short term recession rarely leads to a drop in the level of production; instead, there is merely a deceleration of growth[24]. During the long stagnation, the business cycle is characterized by short (and/or mild) periods of prosperity and long and deep recessions, often giving rise to a fall in the level of activity.

These characteristics of the business cycle in conjunction with long waves were noted early: Kondratieff had pointed them out as far as 1926 (Kondratieff 1935 : 111) and L.H. Dupriez in 1947 (Dupriez 1966 vol. II : 253-257)[25]. Dupriez bases his explanation on the evolution of the

demand for money and credit: "le mouvement long apparait (ainsi) comme conditionnant le mouvement cyclique; par son action sur la demande monétaire et sur le crédit, la hausse fondamentale éloigne le moment où le processus cumulatif de hausse se résout en crise, rapproche le moment où le réajustement de la dépression est suffisant pour donner cours à un nouvel essor; la baisse fondamentale écourte la hausse en créant rapidement les conditions de repli et prolonge la stagnation" (Dupriez 1966 : 255)[26]. Along the same line, Gordon, Weisskopf and Bowles (1983 : 152 and foll.) speak of "reproductive" and "non-reproductive" business cycles. The former endogenously restore conditions for rapid accumulation without requiring fundamental changes in the structure of the accumulation process. In the non-reproductive cycle, on the contrary, a downturn does not correct itself endogenously and therefore it requires basic changes in the institutions that regulate the accumulation process and establish the conditions for profitability. Long swing expansions are characterized by reproductive cycles, long swing crises by non-reproductive cycles (id.: 152-153). The fact that a reproductive cycle becomes nonreproductive signals an erosion of the effectiveness of the institutions of the "Social structure of accumulation" (id. : 154).

(5)

PART II

UNDERSTANDING THE PRESENT SITUATION

The main aspect that throws light on the nature of the present recovery is the technological revolution in computer and information technologies which started in the seventies. The evidence that appears will be supplemented by two other elements giving indirect a support to the conclusion that we are now in the final phase of the long stagnation. They are : the recovery in profitability and the different behaviour of the business cycle(27).

I. The technological revolution of the Seventies

1. In a recent contribution Marchetti (1988) presents an impressive series of graphs concerning a wide spectrum of activities and sectors : all show a logistic curve path, which is in strong accordance with the long wave periodicity. These waves indicate that, in most cases, the initial impulse of the present long wave will reach saturation around 1995. If, in a particular country or activity, the process started later, saturation always arrives towards the end of the general cycle: latecomers have shorter time constraints (Marchetti, 1988 :. 3). Marchetti maintains that "we are now witnessing the 1984-2002 innovation wave to be centred in 1993" and that "our ... [stagnation] should end in 1995" (id. : 2).

Although Marchetti's exercise deserves careful consideration, I think that we must avoid mechanically extrapolating past tendencies. If we can safely say that 1995 will be the year of saturation for the impulse of the 1940s, we need some good reason to infer that a fifth long wave will start around that year. The question, then, is whether there are signs of a new technological revolution which could produce the economic upswing in the 1990s(28).

2. In a period of intense technological change, it is difficult to tell which

innovation(s) will take the form of a technological revolution, since it is only in retrospect with a certain time-lag that one can decide which are the major or minor innovations. Nonetheless, we are now witnessing some strong similarities with the long wave mechanism.

The innovations in the field of computer and information technology which developed in the 1970s in connection with the large scale application of micro-electronics present the characteristics of a technological revolution. They are, in fact, innovations that radically change production methods in an increasing number of industries and services; this change will be even more fundamental when the CIM (computer integrated manufacturing) and CAD (computer assisted design) techniques are further improved and generalized.

Increasing computerization and use of information technologies helps both to create new industries and to rejuvenate old ones[29]. This innovation can not only push automation to its extreme limits but also:

- reduces the scope for technical economies of scale, since it lowers the minimum optimum scale of plant;
- allows for greater flexibility, since the same equipment could produce a range of differentiated products;
- provides higher quality by adding "intelligence" to products
- permits a decentralization of production;
- extends the "limits to growth" by helping to overcome the obstacles imposed by scarcity of natural resources
- has a strong potential impact on labour organization and labour relations within the firm. In some instances, direct labour is almost completely eliminated; in some others, the workers can profitably accomplish a whole range of operations, giving them a large view and control over the production process. In any case, the qualifications required are entirely different[30].

The emerging techno-economic paradigm thus makes it possible to overcome the limitations of the previous one at the productive as well as at the organizational level. The first aspect refers to the diseconomies of scale and

inflexibility of dedicated assembly-line plant and to the obstacles met by mass production with its intensive use of energy and materials. The organizational limitations come from the hierarchical departmentalization of large corporations, which can now be overcome by integrating design, management, production and marketing into one system(31).

As was the case for the previous long waves, the present technological revolution possesses its specific key factor (the "chips") available in almost unlimited quantities at a falling relative price.

Finally, it is easy to see that the computer and information technology revolution fits in with Van Duijn's scheme (table 1) in the sense that it is a process innovation appearing during the depression in an existing industry.

3. Computer and information technology was accompanied, in the eighties, by a cluster of radical innovations(32). They started with the introduction of new materials (optical fibres) and products (laser), developed independently of the computer innovation, and we are now witnessing an interesting and promising combination with the computer (telematics, bio-informatics, sensors and switches). The convergence of information and computer technologies adds another significant example (OECD 1989 : 152). Also, the establishment of networks between information technology-based equipment leeds to a wide creation of knowledge and know-how in the economy which encourages the cumulative adoption of many small innovations (id.: 15).

Biotechnology is at least as revolutionary as the computer and micro-processors. Its potential impact in agriculture is enormous, as genetically transformed plants could solve the famine problem of the Third World. In industry, the scope for biotechnology is more restricted, even though production methods in a wide range of sectors, such as pharmaceuticals, chemicals, food and drink, will change drastically and it could also be possible to apply biotechnology to mineral extraction(33). However, it is quite unlikely that biotechnology could be the basis for a technological revolution

which would pull the economy out of the present long stagnation because it is not yet perfected. For industry and services of the industrialized countries, most of the far-reaching innovations derived from biotechnology will probably be implemented at the beginning of the next century, when the microelectronics paradigm has already become established and produced its economic effects.

4. Adequate empirical evidence on the present technological revolution would provide data on the development of the main "carrier branches", on induced growth sectors as well as on the infrastructures which facilitate the use of new processes and products everywhere and create appropriate externalities. This would cover:

. as main branches: computers, software, electronic capital goods;

. as induced growth sectors: advanced machine tools, measuring, precision and control instruments, industrial robotics and flexible manufacturing systems, "avionics",(34) telecommunication equipment, data banks, information services;

. as infrastructures: digital telecommunications networks, satellites;

. as other radical innovations: optical fibres, new ceramics, fine chemicals.

However, the available data are far from being exhaustive: new products and activities do not fit into the old statistical classifications and, moreover, they are lumped together with other traditional items. The 3-digit Eurostat data base VISA, covering industrial enterprises with 20 and more employees, could provide useful information. Unfortunately, this data base is not coherent with the national accounts, in which the industrial branches are at 2-digit and, all things considered, I prefered to rely on the latter source. The two branches of national accounts whose coverage is not too far from the sectors at the core of the technological revolution are : office and data-processing machines, precision and optical instruments (NACE R25 code 23)

and electrical goods (NACE R25 code 25). Taken together, they cover the "main branches" and part of the induced growth sectors, since telecommunications equipment is included in the electrical goods branch. As a rough proxy of information services based on the new technologies I have taken the "communication services" (NACE R25 code 67). Table 4 indicates that the "new technological paradigm" is clearly under way. In fact, if the growth of value added or investment in the "main branches" is compared with that in manufacturing from 1975 to 1989, we see that, in all countries, the said branches were much more dynamic than the average. In the UK the growth of the office and data-processing machines was particularly strong. In a few cases (UK and Japan) the communication services grew less than the average.

The medium term outlook is even more favourable. According to BIPE *et al.* (1991), for the 1989-95 period the average annual growth rate of output at constant prices in EUR-12 will be : 8.6% for semiconductors; 6.4% for data processing equipment; 15.0% for software services; 8.2% for tecommunications equipment and 6.5 for telecommunication services, whereas, for GDP and total manufacturing, forecast growth is 2.8% per year.

Concerning the advanced machine tools, we should note that in 1978 they represented, in the EC, less than 10% of the sector's production value whereas by 1988, this share amounted to 40% and it is expected that in the second half of the 1990s it will level out at 65% (Atkins 1990: 41-43).

TABLE 4 : Indications of the spreading of the technological revolution, 1975-1989[data at constant prices] (base year 1985)

	Variable	Office and data proc. mach.; instruments			Electrical goods			Communication services		
		Rel. growth index[1]	% share[1]		Rel. growth index[1]	% share[2]		Rel. growth index[1]	% share[3]	
			1975	1989		1975	1989		1975	1989
Germany	VA	109.2	2.7	3.0	138.1	10.4	14.4	141.6	3.6	5.1[7]
	Inv.	103.6	3.9	4.1	126.4	9.4	11.9	136.8[7]	5.2	7.2[7]
France	VA	140.7	3.3	4.6	137.5	7.5	10.3	201.1	3.0	6.0
	Inv.	152.0	2.7	4.1	112.3	6.7	7.5	81.0	5.3	4.3
Italy	VA	150.8[4]	1.8[5]	2.7	123.8[4]	6.5[5]	8.0	140.5[4]	2.3[5]	3.3
	Inv.[4]	98.3[7]	2.5	2.5	145.4[7]	6.7	9.7	125.0[4]	5.7[5]	7.1[7]
UK	VA	310.4	1.1	3.6	116.1	8.6	10.0	79.2	4.9	3.9
	Inv.	219.2	1.5	3.3	139.3	5.7	8.0	99.1	7.0	7.0[7]
USA[6]	VA[6]	139.1	5.7	7.9	143.4	6.3	9.0	128.7	4.3	5.5[6]
	Inv.[6]	171.7	4.3	7.4	235.4	4.5	10.6	86.0	9.1	7.8[6]
Japan	VA[7]	140.0	2.7	3.8	527.4	3.4	17.7	74.0	3.1	2.3[7]
	Inv.[6]	144.7	3.4	4.9	286.2	5.8	16.7	58.4	4.7	2.8[6]

Source : EUROSTAT, National accounts ESA (sectoral data base)

1 Obtained by dividing the index for the individual branch with respect to total manufacturing (for the two industrial branches) or to market services (for the communication services branch)
2 With respect to manufacturing
3 With respect to market services
4 Base year 1980
5 Year 1980
6 Final year 1987
7 Final year 1988

According to sectoral experts (Horn, Klodt and Saunders, in Sharp 1985 ed. : 55), in industrialized countries advanced machine tools have now passed the first stage of the logistic life-cycle function and have entered into the exponential growth phase.

It is interesting to note that the reference to long waves and to the technological revolution enables us to explain what until now was just considered as fact : the dichotomy, in the economic evolution of the last seventeen years, between a small group of industrial branches for which demand remained buoyant despite sluggish economic growth, and the others (Buigues and Goybet 1989). At a 2-digit level of classification these strong-demand sectors are: office and data processing equipment; electrical and electronic equipment and supplies; chemicals and pharmaceuticals. The first two correspond to the main "carrier branches" of the present technological revolution while the third branch, whose performance essentially reflect the growth of fine chemicals, is probably linked with the cluster of radical innovations of the 1980s.

5. We have seen in table 3 that, historically, there was an appreciable shortening of the time lag between invention and innovation : mechanically extrapolating past trends 1992 should coincide with the implementation of 50% of total innovations that will produce the fifth long wave (table 3, row 1). Things are not going faster because there are several obstacles to the diffusion of the computer and information technology innovations (OECD 1989 : 170-176). The first, and perhaps the most important one, is institutional. Managers are not yet prepared to make radical changes in the firm's organization and production processes in order to adopt the new technologies. Even when it is decided that the firm should change, it is often difficult to find "blue or white collar" workers with the appropriate skills to operate the new equipment.

The second obstacle to diffusion is technical: the new technologies are

not yet as perfected as the producers maintain. The CIM (Computer integrated manufacturing) technologies, for instance, are still in their early research phase and we will probably have to wait for about a decade for the emergence of the supplying industries and the effective demand (Arcangeli 1990).

Thirdly, the new technologies are still too expensive. Even though the computer revolution started in the 1970s, for many applications it is still too young for dramatic cuts in the price of new equipment to be possible. For the time being, the expansion of demand is not strong enough to allow enterprises to recover the cost of the new investment in a short period of time.

Finally, an essential requirement for the international diffusion of the information technologies, is the provision of a wideband telecommunications infrastructure; this condition, which calls for massive investment, has not yet been met in Europe.

II. The recovery in profitability

Two main questions will be addressed. The first concerns the general evolution of this indicator : if it accorded with the long wave theory predictions, this would be another factor supporting the hypothesis that our economies are in the second phase of the long stagnation. The second question refers to the nature of the recovery which will take place : is it just the result of the business cycle or is it also an incipient effect of the technological revolution ?

a) Methodological aspects

1. The most appropriate indicator of profitability is the rate of profit of capital advanced, i.e. net fixed capital plus the stock of circulating capital. This measure of profitability is superior to the rate of profit of fixed capital not only because it provides a more realistic level of profitability but also because it takes into consideration the influence, on the rate of profit, of changes in the relative scale of circulating capital(35). At the statistical level, the stock of raw materials, finished products and works in progress forms a close approximation to the stock of circulating capital. Unfortunately these data are not always easily available and, in any case, they are not included in the EUROSTAT national accounts, which is the source utilized here. For this reason, the rate of profit (rp) was calculated with respect to the net capital stock only, according to the following formula:

$$rp = \frac{S}{K} = \frac{S}{VA} \cdot \left(\frac{QT}{PDT}\right)^{-1} \cdot \frac{PVA}{PK} \qquad (1)$$

where: S = net profits, current prices = VA - W = net operating surplus[36]

K = net capital stock at mid-year replacement prices

VA = net value added, current prices

PDT = productivity of labour = VAV/L (2)

VAV = net value added at constant prices

L = total employment

QT = indicator of mechanization = KV/L (3)

KV = net capital stock at constant prices

PVA and PK = implicit prices of value added and fixed capital

We see that the evolution of profitability depends upon three factors :

. the profit share S/VA

. an indicator of the efficiency of capital accumulation. The ratio QT/PDT (capital/output ratio) compares, in fact, the investment to increase mechanisation (QT, i.e. capital per worker) with its results in terms of labour productivity. An increase in this ratio exerts a downward pressure on profitability as too much capital is required to obtain a certain increase in productivity

. the relative prices of value added with respect to the prices of fixed capital. The evolution of PVA/PK is first of all explained by different performances of labour productivity in the sector in question as compared with the sector producing the capital goods for it.

2. For the present investigation it is interesting to ascertain whether the recovery in profitability that will appear is mainly due to the business-cycle or

whether it depends on other factors, in particular the technological revolution. Short-term fluctuations of activity influence profitability in two ways: by the varying degree of capacity utilization and by the restructuring induced by the declining phase of the business cycle.

The first effect depends on the so-called "overhead labour": certain types of labour (administrative, supervisory, maintenance) are employed in proportion to the capacity of the enterprise, while others (production workers) are used in accordance with the actual output. When production temporarily declines, labour-hours of production workers are proportionally reduced; for the other types of labour, an analogous cut is not easily made, and this raises the unit cost of production and reduces profits.

The other influence on profitability comes from the "curative" effect of the business cycle. During the recession, some enterprises go out of business, the remaining restructure themselves and, in this way, increase their rate of profit.

To appreciate the importance of the "overhead labour" effect, one can rectify the rate of profit by dividing it by the rate of capacity utilization and then compare the evolution of the rate of profit with the evolution of the corrected ratio. By doing so, we compare the profitability resulting from potential (full-capacity) labour productivity (PDT*) with actual performance. In fact, defining the rate of capacity utilization (cu) as: cu = VAV/VAV* (4)

where VAV* is potential output at constant prices[37], the rectified rate of profit (rp*) is :

$$rp^* = \frac{rp}{cu} = \frac{S}{VA} \cdot \frac{PDT^*}{QT} \cdot \frac{PVA}{PK} \qquad (5)$$

where PDT* = VAV*/L

Potential output (VAV*) can be derived from the published figures on the rate of capacity utilization :

$$VAV^* = VAV/cu \qquad (6)$$

With regard to the second effect of the business cycle, one should be aware that, unfortunately, it cannot be statistically separated from other influences, e.g. the repercussion of the technological revolution. The causes of the recovery of profitability can thus be judged only on a more qualitative base.

b) **Evidence**

3. As appears in Tables 5 and figures 4 to 8, during the long stagnation profitability followed, in all countries, an evolution similar to that predicted by the long waves theory. In fact, in most cases, the fall in profitability ended in 1981, i.e. towards the end of the depression phase and, from 1982, there was an important recovery. In Italy (manufacturing) (fig. 6) and UK (industry plus transport and communications) (fig. 7), the increase in profitability appeared as early as 1976; the USA economy also experienced a recovery in profitability from the beginning of the 1980s (fig. 8). Japan departs from this general trend because, from 1976 to 1988, profitability was flat (table 5 and fig. 9).

TABLE 5 : The evolution of the rate of profit

	annual % change[1]		Levels (%)			
	period	% change[1]	1960	1970	1981	1987
GERMANY						
manufacturing	1960-81	-4.44	41.1	27.5	12.5	21.9[2]
	1981-90	4.43				
ind. + transp.	1960-82	-3.36	28.0	21.7	11.7	14.5
+ communic.	1982-87	3.31				
FRANCE						
manufacturing	1960-81	-2.85	18.7	18.8	9.7	16.3[2]
	1981-90	3.28				
ind. + transp.	1970-82	-5.58		18.0	9.5	11.5[3]
+ communic.	1982-85	5.17				
ITALIE						
manufacturing	1960-75	-4.11	34.1	29.5	14.0[4]	18.7[2]
	1975-90	0.01				
ind. + transp.	1960-82	-3.97	32.8	32.1	15.0	19.4[7]
+ communic.	1982-90	4.31				
UNITED KINGDOM						
manufacturing	1960-81	-7.51	45.7	25.9	9.7	21.0[2]
	1981-90	9.23				
manufacturing	1960-81	-7.21	16.3	10.4	2.4	11.9
(OECD)[5]	1981-87	19.47				
ind. + transp.	1972-75	-21.01		19.0[6]	8.5[4]	18.8[7]
+ communic.	1975-88	5.49				
ind. + transp.	1960-75	-5.36	11.8	8.2	7.1	12.7
+ communic.	1975-87	6.91				
(OECD)[5]						
NFE (OECD)[5]	1960-75	-7.18	13.5	7.5	4.9	9.2
	1975-87	4.91				
USA						
manufacturing	1960-82	-4.63	26.9	19.4	12.8	16.4
(OECD)[5]	1982-87	4.10				
JAPAN						
NFE (OECD)[5]	1970-75	-14.77		34.8	16.3	15.7[7]
	1975-88	0.17				

Source : EUROSTAT (unless otherwise indicated) : sectoral data base and data base on capital stock. For 1989 and 1990 data on capital stock are provisional. NFA = non farm non financial enterprises.

1 Average annual rate of change of the exponential trend (bx100) obtained by a spline regression of the function : $x = a\,e^{bt}$, or $\lg x = \lg a + bt$, where x represents the rate of profit and t time (1, 2....).
For the second sub-period, figures refer to the rate of change calculated on the basis of the changes in slope of the regression. The ratio of the parameters to their standard errors are always higher than 2.

2 Year 1990. Data for this year is provisional.

3 Year 1985.

4 Year 1975.

5 OECD. Profits at factor costs instead of market prices. Moreover, OECD definition of manufacturing is that of the old system of national accounts and thus differs from ESC.

6 Year 1972.

7 Year 1988.

Fig. 4 : THE RATE OF PROFIT OF FIXED CAPITAL
GERMANY

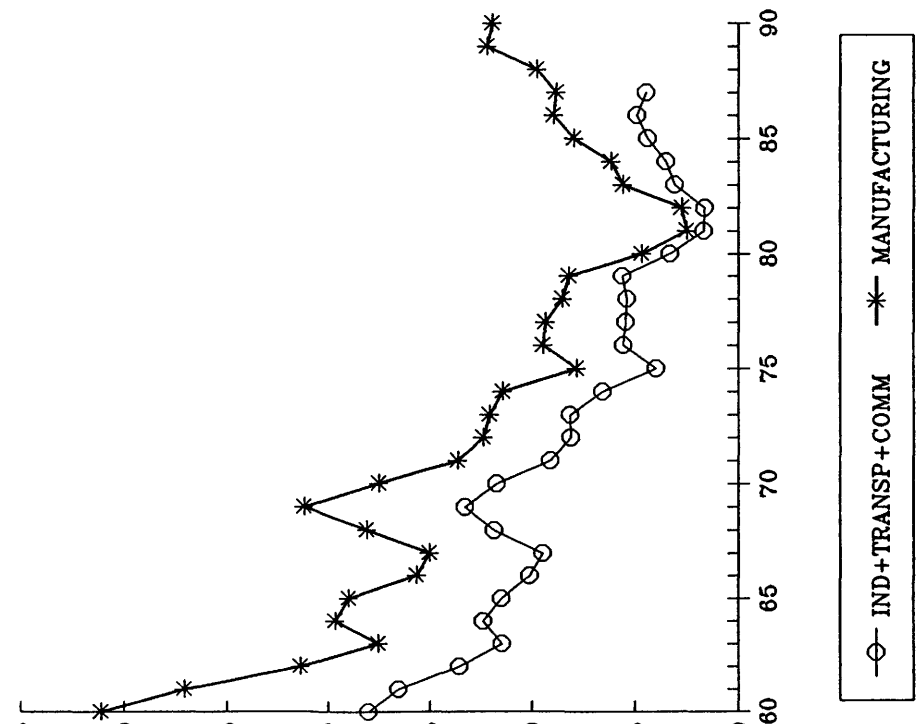


Fig. 5 : THE RATE OF PROFIT OF FIXED CAPITAL
FRANCE

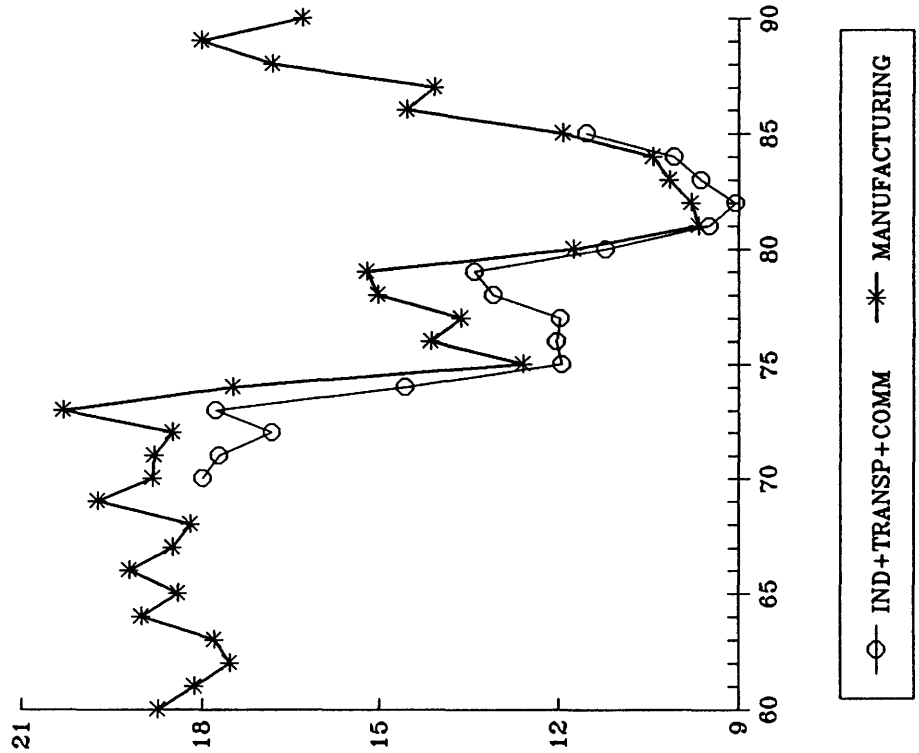


Fig. 6 : THE RATE OF PROFIT OF FIXED CAPITAL
ITALY

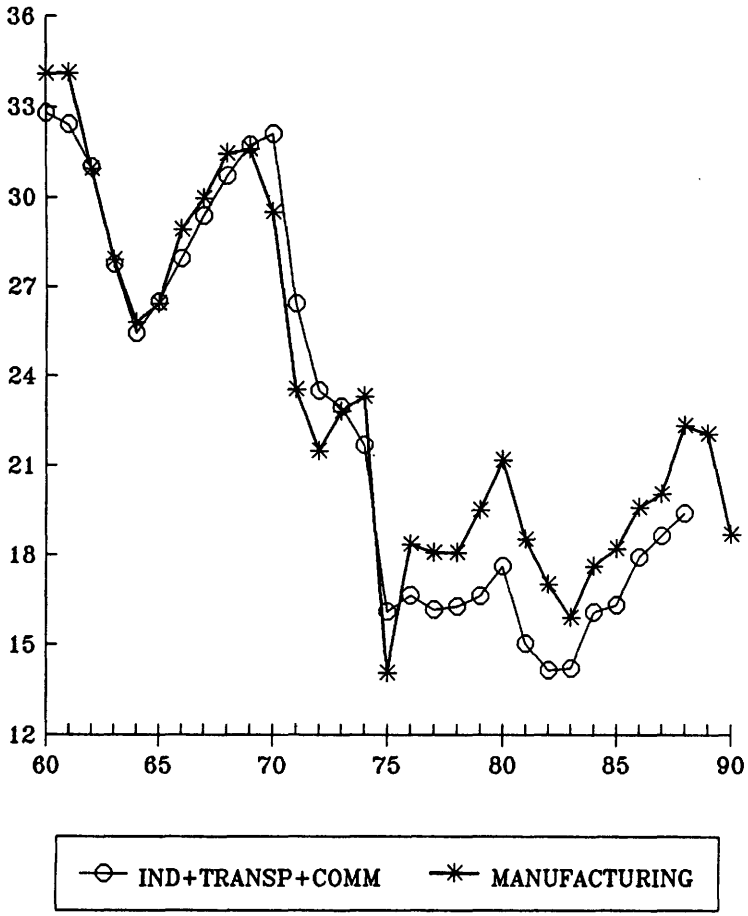


Fig. 7 :

UK : RATE OF PROFIT OF FIXED CAPITAL.

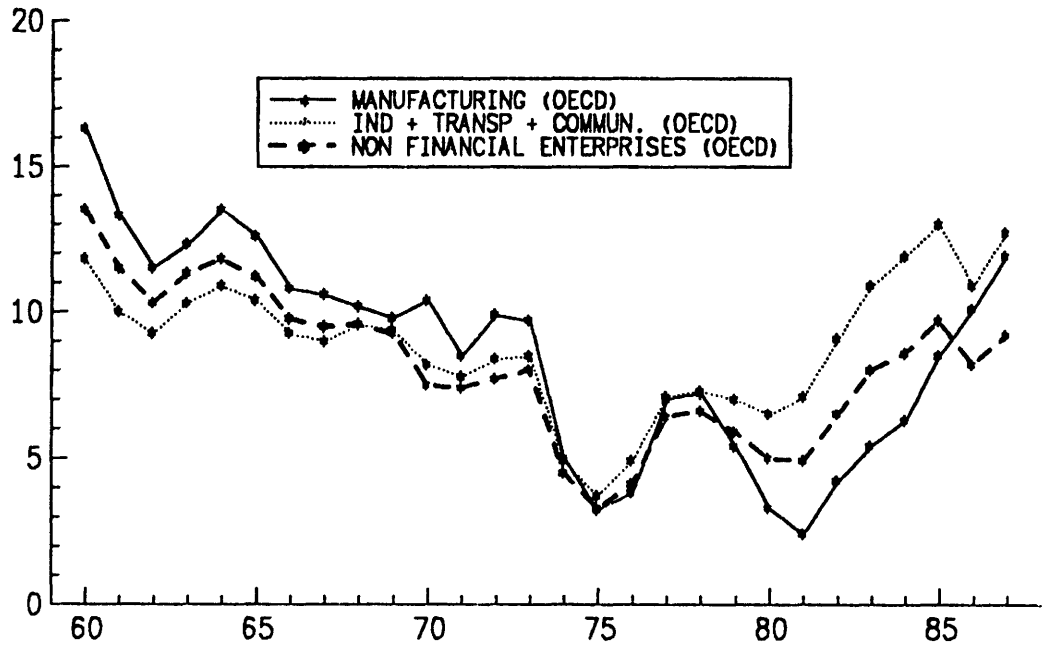


Fig. 8: THE RATE OF PROFIT OF FIXED CAPITAL
U.S.A.
MANUFACTURING (OECD)

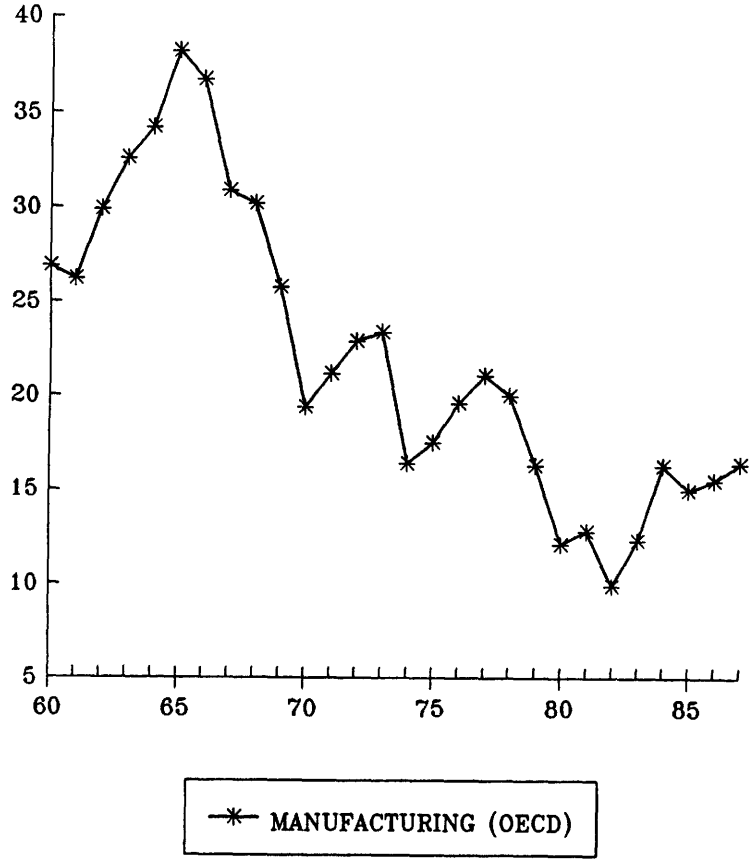
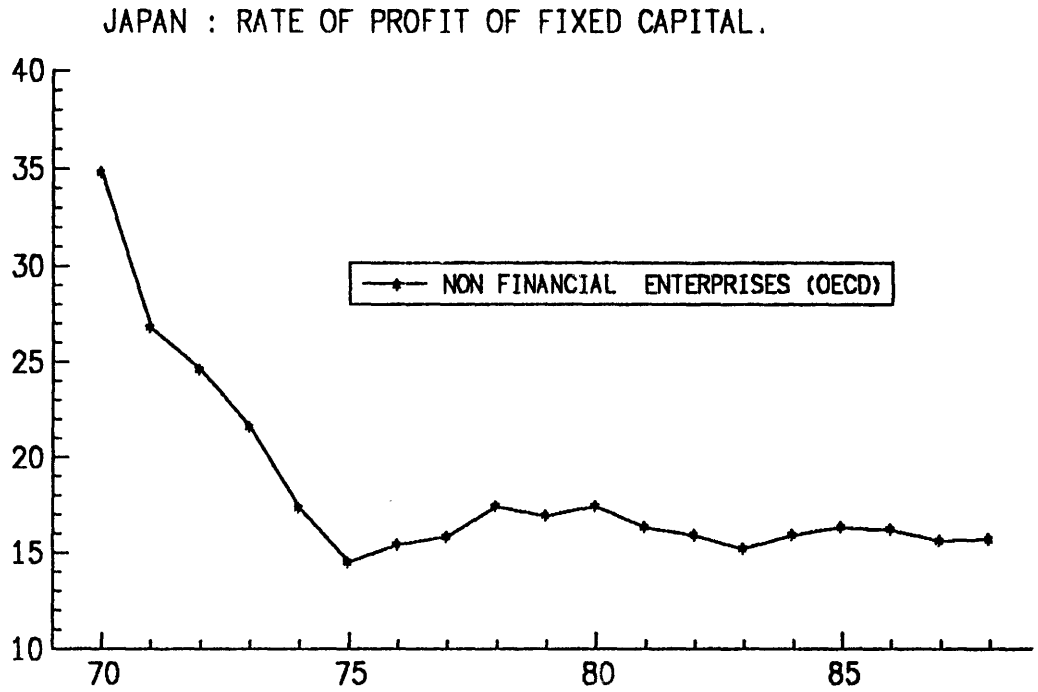


Fig. 9:



The rise of the eighties brought the rate of profit in manufacturing to the early seventies level.

Note that the evolution of the rate of profit in UK is heavily dependent on the method of estimating the capital stock. In fact, if we take OECD data, we see not only a big difference in level but also that the long term decline is less accentuated than it appears from Eurostat data, and the rise since 1982 is much greater (table 5). According to the OECD source, the 1987 level (11.9%) is slightly higher than in 1962, and not too far from the cyclical peak of 1964 (13.5%).

4. Figures 11 and 13 show that, during the last twenty years, short term fluctuations in the degree of capacity utilization had no influence on the evolution of the rate of profit in British and French manufacturing. It is only in Germany and Italy that this factor had a more discernible influence, although it remained within a narrow range (figures 10 and 12).

5. Let us now examine the determinants of the evolution of profitability in manufacturing, splitting the rate of profit into its components as in formula 1. Of course, it should be not considered that this exercise shows a true causality because the second relationship of formula 1 is an identity: as such, it offers no single unique behavioural explanation. Nevertheless this analysis provides some further insights into the long-term movement of profitability.

Table 6 shows that, in all countries, the factor which most influenced the evolution of profitability was income distribution. During the long expansion and the depression phase of the long wave, the decrease in profit share (S/VA) pushed the rate of profit downward; during the second phase of the long stagnation (the recovery), the opposite movement prevailed and, as it can be seen from table 6 comparing the increase of the rate of profit with

Fig. 10 : THE INFLUENCE OF CAPACITY UTILISATION ON PROFITABILITY IN MANUFACTURING. GERMANY (1970 = 100)

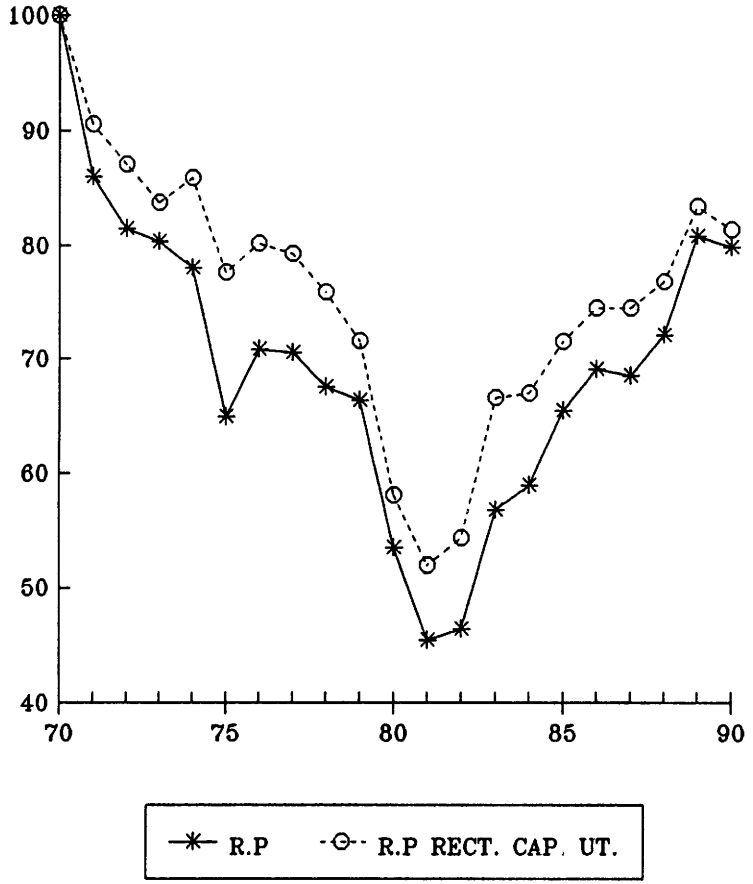


Fig. 11 : THE INFLUENCE OF CAPACITY UTILISATION ON PROFITABILITY IN MANUFACTURING. FRANCE 1970 = 100

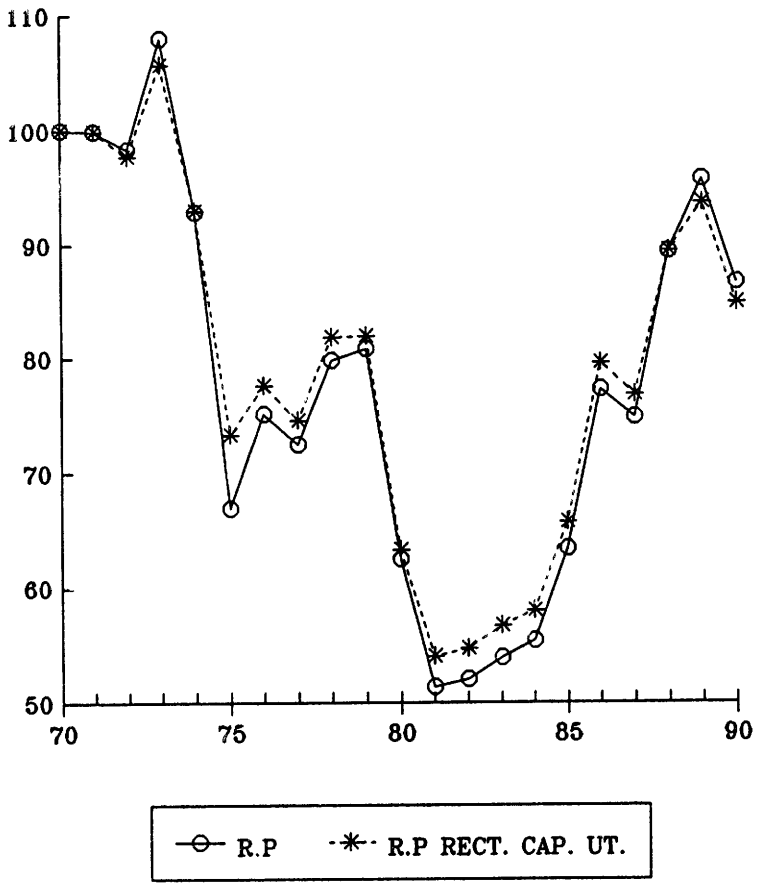


Fig. 12: THE INFLUENCE OF CAPACITY UTILISATION OF PROFITABILITY IN MANUFACTURING. ITALY 1970 = 100

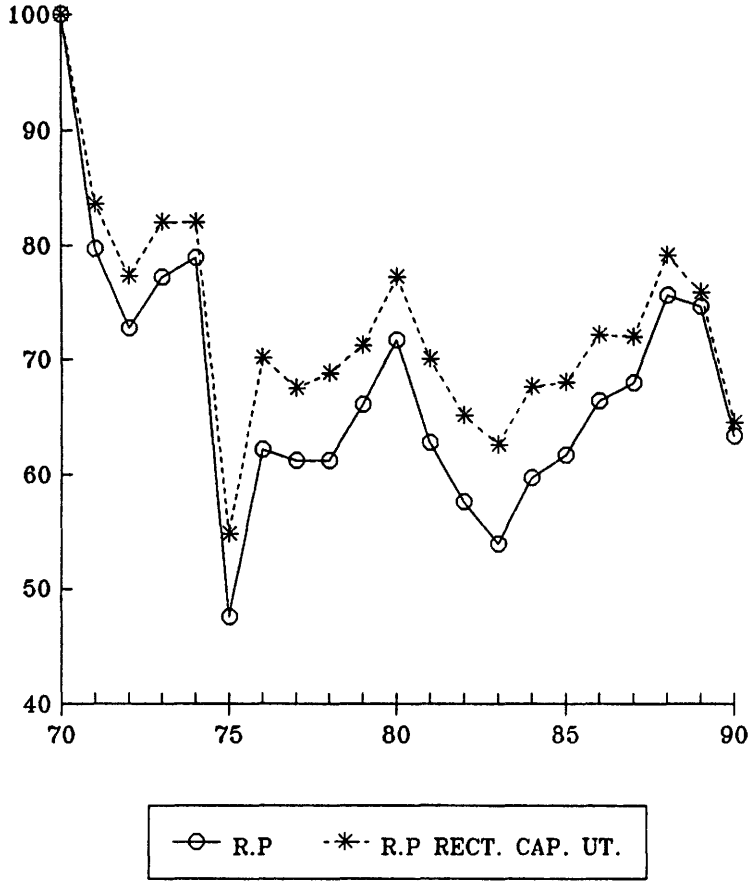


Fig. 13: THE INFLUENCE OF CAPACITY UTILISATION OF PROFITABILITY IN MANUFACTURING. UNITED KINGDOM (1970 = 100)

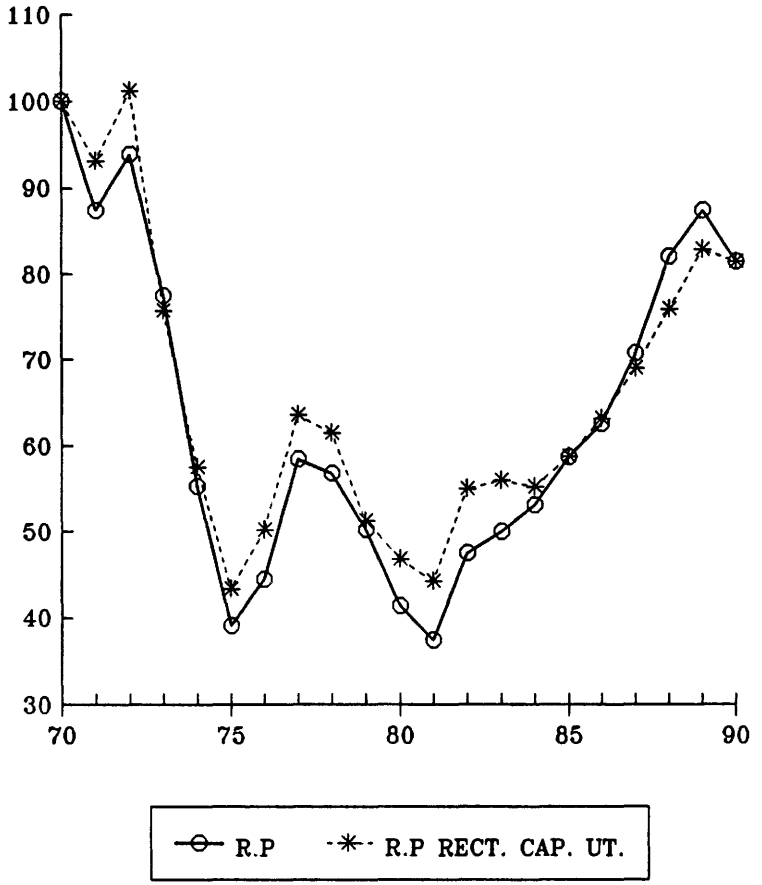


TABLE 6 : The rate of profit and its components in manufacturing industry (average annual rate of change of the exponential trend)[1]

Country	Period	rp	S/VA	QT/PDT	PVA/PK
Germany	1960-81	-4.44	-3.36	0.61	-0.47
	1981-90	4.43	3.11	-0.41	0.91
France	1960-81	-2.85	-3.19	-0.95	-0.60
	1981-90	3.28	4.48	1.03	-0.17*
Italy	1960-75	-4.11	-3.12	-1.47	-2.45
	1975-90	0.01	1.45	-0.14	-1.58
United	1960-81	-7.51	-4.41	1.91	-1.19
Kingdom	1981-90	9.23	7.32	-1.67	0.24

(1) Calculated as in Table 3 (spline regressions). Instance where the ratio of the parameter to its standard error is less than 2 is indicated with an asterisk.

the increase of profit share, the improvement in profitability was mainly determined by the parallel movement of the profit share.

The net effect of capital accumulation (ratio QT/PDT) had an important effect on profitability both during the long expansion and the long stagnation in UK manufacturing : until 1981 the sharp increase in this ratio depressed profitability; from 1982 this trend was reversed, thus reinforcing the upward pressure on the rate of profit already stemming from the profit share (figure 15). In other words, during the long expansion and the first part of the long stagnation capital accumulation was inefficient, as more and more equipment was required to improve productivity; it was only during the recovery phase of the stagnation that capital accumulation became efficient, since the increase in the degree of mechanization (QT) was associated with larger increases in labour productivity.

In France and Italy the net influence of capital accumulation was relatively great in the Sixties, when it exerted a favourable influence on profitability (fig. 13 and 14). Conversely, in Germany the ratio QT/PDT had only a minor effect on profitability both during the long expansion and the long stagnation (fig. 12).

The evolution of the relative prices of value added (PVA/PK) had a negative effect on profitability, except in Germany and UK, for the period 1981-1990. This adverse effect was greater in Italy. This means that, because of internal and international competition, manufacturing was unable to pass on the increasing cost of plant and equipment in its selling prices. The main beneficiary was the construction industry(38), a sector protected from international competition.

6. Let us now compare profitability in the branches at the core of the technological revolution with profitability in manufacturing. This will provide further information on the nature of the recovery in the rate of profit already noted.

Table 7 shows that, in Germany and the United Kingdom, the increase in profitability of the electrical goods sector was much greater than in manufacturing while, in France and Italy, the trend of the rate of profit was declining. In office and data processing machines, profitability was growing in the UK (although by less than in total manufacturing) while, in the other countries, it was declining (Germany) or stationary (France, Italy).

A comparison of these results with what emerges from table 4 in terms of output allows us to conclude that, in Germany and the UK, the increase in industrial profitability is dependent on the technological revolution. The electrical goods sector, in fact, accounts for more than 10% of industrial output in these countries : its profitability has therefore a direct dimension effect on the performances of industry. In the other countries, the influence of the business cycle predominates.

Fig. 14: GERMANY
THE RATE OF PROFIT AND ITS COMPONENTS
MANUFACTURING (1960=100)

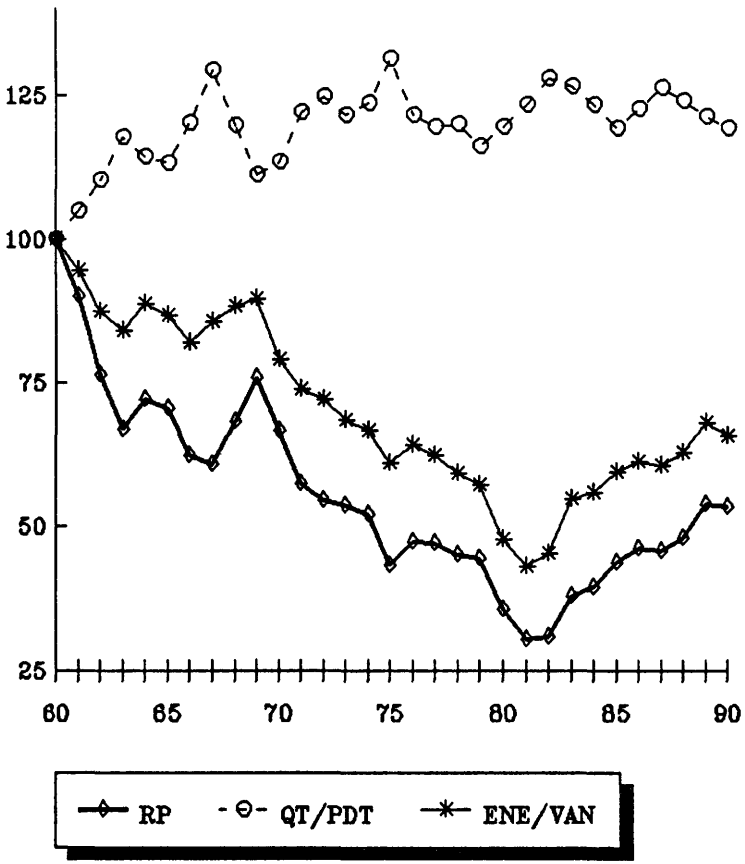


Fig. 15: FRANCE
THE RATE OF PROFIT AND ITS COMPONENTS
MANUFACTURING (1960 = 100)

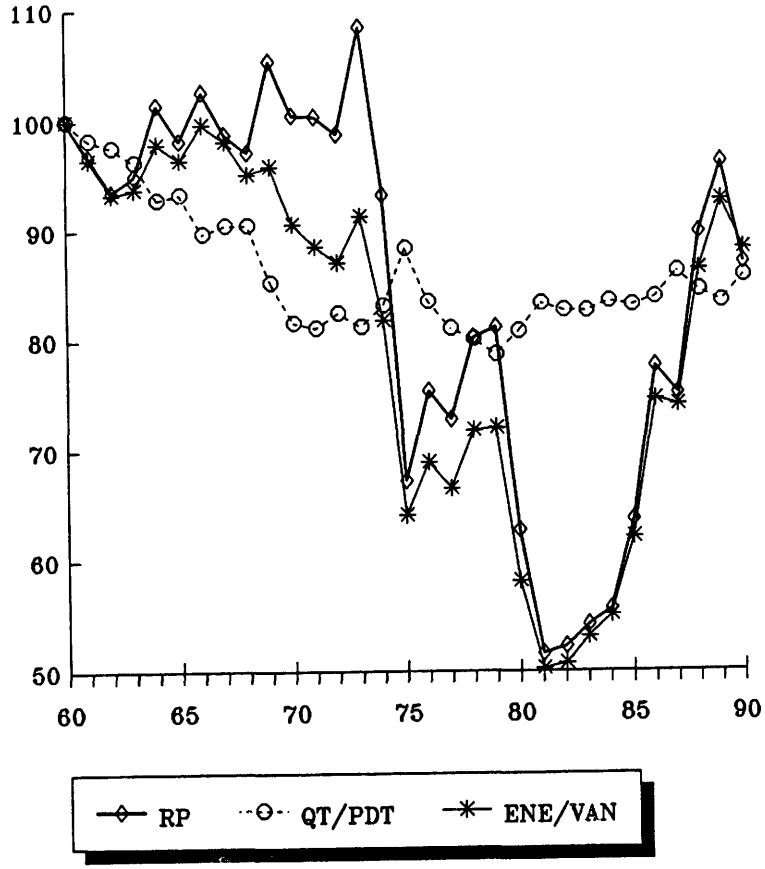


Fig. 16 :

ITALY
THE RATE OF PROFIT AND ITS COMPONENTS
MANUFACTURING (1960 = 100)

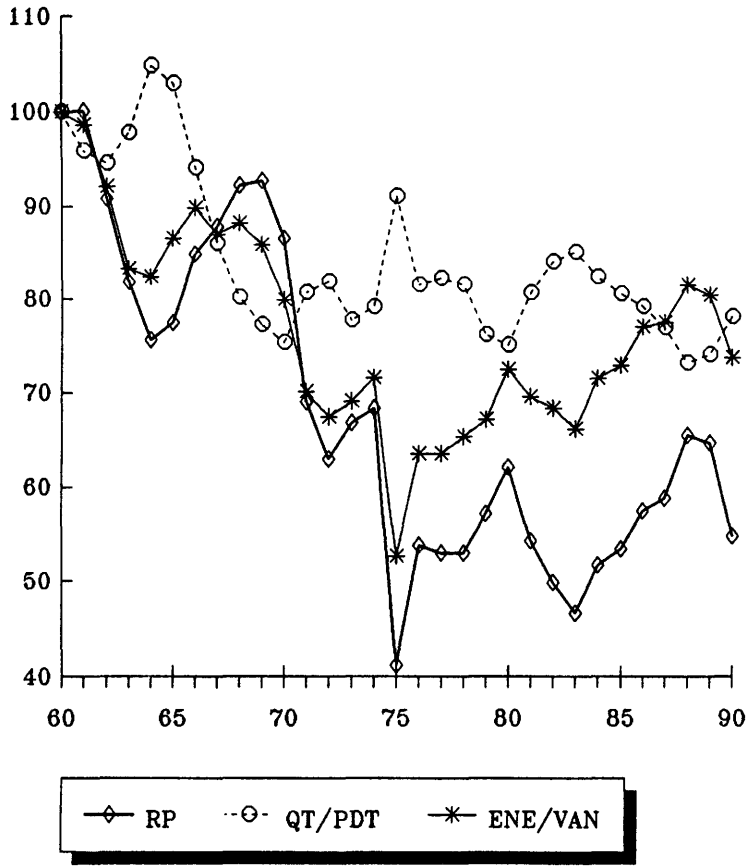


Fig. 17 :

UNITED KINGDOM
THE RATE OF PROFIT AND ITS COMPONENTS
MANUFACTURING (1960 = 100)

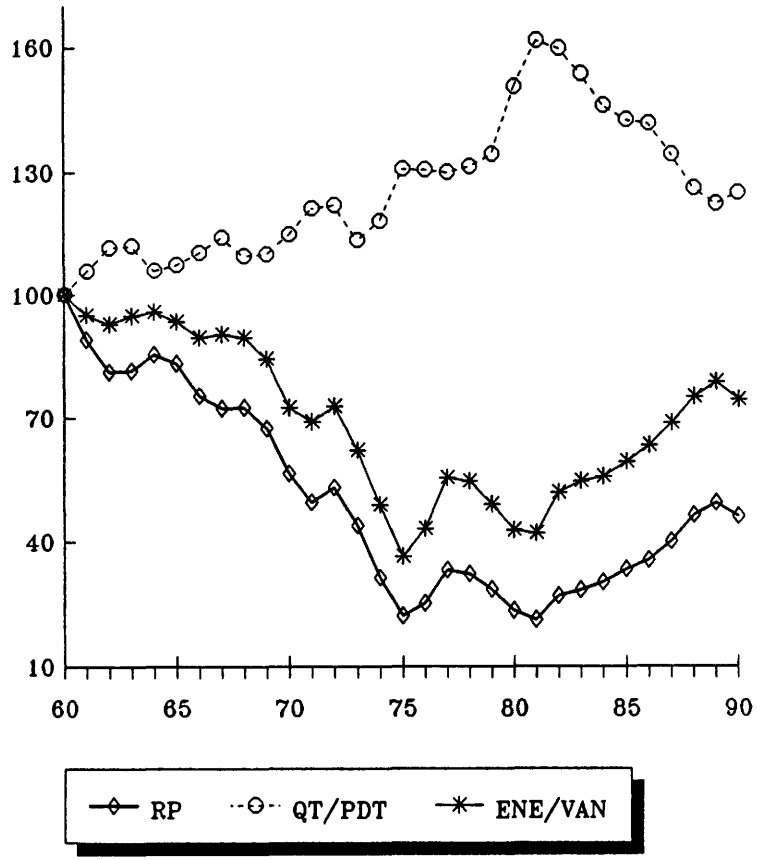


TABLE 7 : The evolution of profitability in the branches at the core of the technological revolution

(average annual rate of change of the exponential trend)

	Periods	annual % change[1]	Levels		
			1975	1981	1990
GERMANY					
office and data proc. machines; instruments	1975-90	-7.58[3]	24.3	20.6	14.5
electrical goods	1975-81	-7.31	17.6	8.9	25.9
	1981-90	8.21			
manufacturing[2]	1975-81	-6.80	17.9	12.5	21.9
	1981-90	5.54			
FRANCE					
office and data proc. machines; instruments	1975-90	-0.64*[3]	34.5	22.5	25.4
electrical goods	1975-82	-8.68	34.6	21.3	18.8
	1982-90	-1.82			
manufacturing	1975-82	-5.82	12.6	9.7	16.3
	1982-90	7.17			
ITALY					
office and data proc. machines; instruments	1975-90	1.74*[3]	15.7	34.7	30.4
electrical goods	1975-90	-1.82*[3]	11.3	17.3	11.2
manufacturing	1975-90	1.32	14.0	18.5	18.7
UNITED KINGDOM					
office and data proc. machines; instruments	1975-90	2.70[3]	19.50	22.50	29.7
electrical goods	1975-90	7.71[3]	4.8	10.6	20.2
manufacturing	1975-90	4.39	10.1	9.7	21.0

Source : EUROSTAT : sectoral data base

1 Calculated as in Table 6. Spline regressions where there is a sub-period. The asterisk has the same meaning.

2 The differences with respect to the growth rates reported in Table 4 are due to the "harmonica effect" resulting from the spline regression.

3 For this variable there is no break in the trend.

III. The behaviour of the business cycles

1. This aspect plays a subsidiary role with respect to the other two points developed in paragraphs I and II above. Indeed, the finding in that the present business cycle is following an atypical pattern does not, by itself, prove that the underlying long term trend is changing. However, if we consider that there are two other arguments supporting this thesis (the technological revolution and the recovery in profitability), the business-cycle argument reinforces the conclusions that can be drawn from the previous stage of the analysis.

For this purpose I shall compare the length of the prosperity phase which started around 1982 with the same phases of the previous cycles. This exercise will also provide an opportunity of verifying whether the evidence available supports or contradicts the predictions of the theory that the business cycle pattern varies according to the phases of the long wave. Identifying peaks and troughs of the business cycles presents almost the same difficulties and uncertainties as detecting long waves. Here too the trend elimination procedure is crucial, because it influences the dates of peaks and troughs. Below I have taken the evidence provided by OECD (1987); the method of trend estimation used is the Phase-Average Trend developed by the NBER (see OECD 1987 : 33-37 for the description). I focussed on industrial production rather than on GDP because the former series are monthly, and thus make it possible to determine the turning points of the cycles with more detail. In any case, the business cycles chronology derived from GDP does not differ substantially from that obtained on the basis of industrial production.

2. The dates of the cycles in the four major member countries, the aggregate EC-4 as well as the USA are reported in Table 8. As stated in footnote 6 of the table 8, the true peak of the present cycle is still unknown since the cycle is incomplete. In Germany and the USA, it seems that the

1982 cycle had a sub-cycle. For the UK, the existence of a possible sub-cycle with a trough in 1984 is not unanimously recognized because major strikes took place in 1984.

The first striking result is the difference between the average length of the prosperity phases of the past business cycles and the length of the prosperity phase which began in the early eighties. This is even more marked if the comparison is limited to the long expansion (from the 1950s to 1973). Table 6 shows, in fact, that the present prosperity phase is two to three times longer than the average duration of the same phase in the past.

TABLE 10:

BUSINESS CYCLES CHRONOLOGY (1-2-3)

Total industrial production

C Y C L E S				Trough to peak		Peak to trough	
	Initial trough	Peak	Final trough	Dur. mths	Ampli-tude[4]	Dur. mths	Ampli-tude[4]
GERMANY							
I	.....	1956/7	1959/4			33	- 7.1
II	1959/4	1961/3	1963/2	23	+11.2	23	- 8.5
III	1963/2	1965/1	1967/5	23	+11.7	28	-17.0
IV	1967/5	1970/5	1971/12	36	+14.1	19	- 8.6
V	1971/12	1973/8	1975/7	20	+10.7	23	-15.7
VI	1975/7	1979/12	1982/12	53	+16.6	36	-14.9
VIa	*1975/7*	*1977/3*	*1978/3*	*20*	*+10.9*	*12*	*- 4.7*
VIb	*1978/3*	*1979/12*	*1982/12*	*21*	*+10.4*	*12*	*-14.9*
VII	1982/12	*[1990/12][6]*		*[96]*			
VIIa[5]	*1982/12*	*1986/4*	*1987/2*	*40*	*+11.2*	*10*	*- 5.4*
FRANCE							
I		1958/1	1959/1			12	- 9.9
II	1959/1	1960/9	1963/3	20	+ 6.4	30	- 7.6
III	1963/3	1964/1	1967/10	10	+10.8	45	- 7.4
IIIa	*1963/3*	*1964/1*	*1965/1*	*10*	*+10.8*	*12*	*- 6.5*
IIIb	*1965/1*	*1966/7*	*1967/10*	*18*	*+ 4.0*	*15*	*- 4.9*
IV	1967/10	1969/5	1971/5	19	+ 6.5	24	- 8.9
V	1971/5	1974/7	1975/5	38	+12.2	10	-17.9
VI	1975/5	1979/7	1982/8	50	+18.6	37	-12.6
VIa	*1975/5*	*1977/1*	*1977/12*	*20*	*+13.4*	*11*	*- 6.0*
VIb	*1977/12*	*1979/7*	*1982/8*	*19*	*+11.2*	*37*	*-12.6*
VII	1982/8	1990/7[7]		95	+8.0		

CYCLES				Trough to peak		Peak to trough	
	Initial trough	Peak	Final trough	Dur. mths	Amplitude[4]	Dur. mths	Amplitude[4]
ITALY							
I		1955/6	1958/5			35	- 8.9
II	1958/5	1963/9	1965/3	64	+16.6	18	-14.5
IIa	*1958/5*	*1960/6*	*1960/12*	*25*	*+12.3*	*6*	*- 3.3*
IIb	*1960/12*	*1962/1*	*1962/9*	*13*	*+ 7.3*	*8*	*- 4.8*
IIc	*1962/9*	*1963/9*	*1965/3*	*12*	+ 4.9	*18*	*-14.5*
III	1965/3	1969/1	1972/4	46	+12.6	39	-11.8
IIIa	*1965/3*	*1967/2*	*1968/3*	*23*	*+10.2*	*13*	*- 2.7*
IIIb	*1968/3*	*1969/1*	*1972/4*	*10*	*+ 5.1*	*39*	*-11.8*
IV	1972/4	1974/1	1975/5	21	+16.1	16	-20.4
V	1975/5	1980/4	1983/6	59	+23.1	38	-23.2
Va	*1975/5*	*1976/12*	*1977/12*	*19*	*+19.0*	*12*	*-14.6*
Vb	*1977/12*	*1980/4*	*1983/6*	*28*	*+18.7*	*38*	*-23.2*
VI	1983/6	1989/12[7]		78	+12.5		
UNITED KINGDOM							
I		1957/6	1958/10			16	- 6.5
II	1958/10	1960/3	1963/1	17	+ 8.9	34	-12.1
III	1963/1	1965/5	1967/8	28	+10.7	27	- 6.9
IV	1967/8	1969/6	1972/2	22	+ 7.6	32	-13.4
V	1972/2	1973/6	1975/8	16	+15.7	26	-14.8
VI	1975/8	1979/6	1981/5	46	+19.3	23	-18.0
VII	1981/5	1988/9[7]		88	+ 7.2		

CYCLES				Trough to peak		Peak to trough	
	Initial trough	Peak	Final trough	Dur. mths	Amplitude[4]	Dur. mths	Amplitude[4]
EUR 4							
I		1961/3	1963/2			23	- 5.0
II	1963/2	1964/2	1967/4	12	+ 5.4	38	- 6.4
IIa	*1963/2*	*1964/2*	*1965/7*	*12*	*+ 5.4*	*17*	*- 4.0*
IIb	*1965/7*	*1966/3*	*1967/4*	*8*	*+ 3.1*	*13*	*- 5.5*
III	1967/4	1970/3	1972/1	35	+ 6.5	22	- 6.0
IV	1972/1	1973/9	1975/6	20	+ 8.9	21	-14.0
V	1975/6	1980/1	1982/11	55	+15.3	34	-12.3
Va	*1975/6*	*1977/1*	*1978/2*	*19*	*+10.4*	*13*	*- 2.7*
Vb	*1978/2*	*1980/1*	*1982/11*	*23*	*+ 7.6*	*22*	*-12.3*
VI	1982/11	*[1990/12][6]*	*[97]*				
U.S.A.							
I	1958/4	1960/1	1962/12	21	+18.9	35	-11.3
Ia	*1958/4*	*1960/1*	*1961/2*	*21*	*+18.9*	*13*	-14.4
Ib	*1961/2*	*1961/12*	*1962/12*	*10*	*+ 6.3*	*12*	*- 3.2*
II	1962/12	1966/10	1967/7	46	+ 6.0	9	- 5.3
IIa	*1962/12*	*1963/5*	*1964/10*	*5*	*+ 2.2*	*17*	*- 3.5*
IIb	*1964/10*	*1966/10*	*1967/7*	*24*	*+ 7.3*	*9*	*- 5.3*
III	1967/7	1969/8	1970/11	25	+ 7.4	15	-12.5
IV	1970/11	1973/9	1975/3	34	+14.2	18	-19.7
V	1975/3	1979/3	1982/11	48	+21.3	44	-21.0
Va	*1975/3*	*1979/3*	*1980/7*	*48*	*+21.3*	*16*	*-21.4*
Vb	*1980/7*	*1981/7*	*1982/11*	*12*	*+ 6.9*	*16*	*-15.5*
VI	1982/11	1989/4[7]		77			
VIa[5]	*1982/11*	*1984/8*	*1986/9*	*21*	*+14.8*	*25*	*- 5.1*
VIb	*1986/9*	*1989/4[7]*		*31*	*+5.2*		

1 Source : OECD (1987), *OECD leading indicators and business cycles in member countries 1960-1985,* supplement nr.39, January, to Main Economic Indicators.

2 Information on cycles before 1960 were communicated directly by OECD services.

3 Figures in italics refer to sub-cycles.

4 Amplitude of the prosperity phase (+) or recession phase (-) is measured as a percentage of the trend : percentage above trend at peak plus percentage below trend at trough (OECD 1987, p.74).

5 This chronology is provisional.

6 1990/12 is not the true peak of the cycle, but it is taken just to give a rough approximation of the duration of the present prosperity.

7 Provisional. Communicated directly by OECD services

The explanation for this anomaly is complex. There is, first, the normal play of the business cycle mechanism, in which the recovery in profitability stimulates investment which, in turn, fosters aggregate demand. Second, this dynamic has certainly been reinforced by the "1992 effect", which has helped to create a self-sustaining expansionary climate. Third, it is very likely that the present prosperity is also (and mainly) due to the direct and indirect effects of the technological revolution on investment and on the level of activity.

Table 4 has already indicated the direct effect : over the last decade, the growth of the sectors directly involved with the technological revolution has been much higher than the growth of industry as a whole. Table 4 also shows that, in 1989, the importance of these branches is far from negligible, and that it increased substantially over time. In fact, in 1989 the office and data processing machines and the electrical goods sectors ranged from 10.7% in Italy to 17.3% in Germany of value added in manufacturing, as against 8.3% and 14.3% respectively in 1980. Since that this direct dimension effect on the overall performances of industry.is amplified by the induced effects, it seems reasonable to infer that the technological revolution plays an essential role in explaining the cyclical prosperity.

The cause of the present widespread dynamism is usually linked to the 1992 objective; there could also be another interpretation, namely that something new was under way, and that the completion of the internal market was one of the institutional changes required to speed the process of emerging from the long stagnation.

3. Let us now consider the question of the varying pattern of the business cycle, depending on the phases of the long wave. As recalled in part I of this paper, theoretical reasons and historical experience indicate that, during the long upswing, the prosperity phase of the business cycle is longer and/or more accentuated than the recession, whereas the converse is true for the long

stagnation.

What emerges from the evidence presented in tables 8 and 9 ? Unfortunately, the picture is not clear-cut: some findings bear out the theory and others do not. Let us start with the latter. All things considered, the information in Table 6 tends to disprove the predictions of the theory. This conclusion is unambiguous if we consider the long stagnation: in all countries the business cycle starting in 1975 had a prosperity phase which was much longer than the recession. This is the exact opposite of what the theory says.

Let us now consider the business cycles of the long expansion, from the fifties to the 1971-2/1975 cycle, situated at the turning point of the long wave. Italy and the USA confirm the theory: in every cycle the duration of the prosperity phase is clearly longer than that of the recession[39]. On the other hand, for Germany, France, the United Kingdom, and EC-4, in most cases the recession was longer than the prosperity phase. However, if the average length of the two phases is calculated over the period in question (table 9), the picture changes somewhat.

In Germany, despite the fact that during three cycles the prosperity phase was shorter than the recession, the average duration of the first is longer than that of the second (table 7), because of the long (and pronounced) upswing of the 1967/1971 cycle. Moreover, if the sub-cycles are taken into consideration, France and the EC-4 (in which, according to the main cycles, depression was longer than prosperity) now have an average length of depression slightly shorter than prosperity.

TABLE 9 : Average length (months) of the phases of the business cycles during the long expansion
Total industrial production (1)

	Prosperity	Recession
Germany	25.5	23.3
France	21.8 (21.0)	27.3 (18.2)
Italy	43.7	24.3
UK	20.8	29.8
EC-4	22.3 (18.8)	27.0 (18.3)
USA	31.5 (19.8)	19.3 (14.0)

(1) Figures in brackets are determined by taking the sub-cycles into consideration. The others refer only to major cycles

IV. CONCLUSIONS

1. The answer to the question asked in the title of this paper is : probably, yes.

This assessment is derived from the long waves theory, which is used as a general background. The review of the salient aspects of this approach (Part I) shows that this theory provides an interesting and satisfactory explanation of the long term dynamic of capitalist economies. Moreover, recent evidence which uses new filtering techniques seems to settle the endless controversy on the existence of long waves in production : it now seems very reasonable to assume that long waves actually exist.

One of the main explanations for long waves is the Schumpeterian idea of the technological revolution. Historical experience shows that radical innovations appear in clusters and strong statistical support was also found for this point. The driving force is investment: radically different plant and equipment makes existing plant obsolete, thus creating the need for massive replacement. The investment boom that follows starts a cumulative process of expansion.

However, as was demonstrated by the French-Anglo-American schools of "regulation" and "techno-economic paradigms", the long upswing cannot start unless the technological revolution is accompanied by appropriate changes in the institutional set.

To complete the picture, one should add the crucial role of the rate of profit, the evolution of which is one of the causes of the lower and upper turning points in the long wave.

2. The present situation shows some striking similarities with the long wave mechanism, thus justifying the opinion that we have now entered the second phase of the long stagnation which began in 1974 (the recovery) and that, probably, the new long wave (the fifth) could start in the nineties.

In fact :

a) the computer and information technology innovations which have been progressively introduced since the seventies present all the characteristics of a technological revolution in the Schumpeterian sense;

b) these innovations were accompanied, especially in the eighties, by a cluster of other radical innovations;

c) in the four major European countries as well as in the USA there was a sharp increase in profitability in the eighties; this brought the rate of profit in manufacturing to the early seventies level. To begin with, this positive change in profitability was associated with the movement of the business cycle; afterwards, in Germany and the UK it was influenced by the favourable results of the branches situated at the core of the technological revolution;

d) since 1982 the business cycle follows an atypical pattern, with the prosperity phase being the longest ever recorded since the fifties. If this anomalous result is linked with the findings of the previous analysis (points a, b, c above), it points even more convincingly to the conclusion that we are now in the recovery phase of the long stagnation. The conclusion is borne out by a further point, namely the direct influence on the overall industrial performance of the accelerated growth of the branches which are at the core of the technological revolution.

3. The processes underlying the present situation can be summarized as follows :

- the depression of the second half of the seventies radically changed the relative strengths of social groups. Mass unemployment undermined the Unions' ability to obtain better wages and improved working conditions, real wages stagnated and the profit share increased. Initially, this was the main determinant of the recovery in profitability;
- the raising rate of profit had a twofold effects : it stimulated cyclical prosperity (forming the 1975/82 cycle)[40] and helped the spread of the

technological revolution;

- as new technologies penetrated the economy, they pushed up labour productivity and this further reinforced the upward movement of the rate of profit. The persistent stagnation (or small increase) of real wages in fact ment that profits were the main beneficiary of productivity increases;
- the generalized recovery in profitability since 1982 now replicates, on a larger scale, the "virtuous circle" of the 1975/82 cycle.

4. Two "exogenous" factors can magnify the present favourable long-term prospects. The first is the development of the East European countries: if the outcome of the present situation is favourable, a huge market will be available for EEC industry. This will provide an exceptional stimulus for the growth process already in operation.

The second factor is the completion of the internal market. While the present success of the 1992 objective probably stems from the fact that the new long wave was already "in the pipeline", the institutional changes that are being implemented will substantially reinforce the underlying movement.

5. However, it should be noted that the picture is not entirely rosy: the favourable prospects described are subject to several uncertainties and, in any case, a new long upswing will not automatically solve all the economic and social problems inherited from the long stagnation.

The most fundamental obstacle to growth is represented by domestic and international inequalities, a factor that delays the beginning of the fifth long wave and that could even stop it. The mass unemployment of the 1970s together with economic policies sharply increased domestic inequalities in many European countries and in the USA, and they now remain severe. To begin with, this development was considered favourable by many people because it shifted the balance of powers in favour of enterprises, but there is now a growing awareness that such unbalanced income distribution will not

provide adequate demand for growing output (Tylecote, 1990).

The international aspect of inequality relates to the widening gap between the North and the South of the world. In the short run such inequality does not seem to threaten world stability, but this will certainly not be the case in the long run. Western countries could thus go on developing only if the problem of world poverty is solved. As recently pointed out in the Brundtland report, this is also the condition on which a major ecological disaster can be avoided.

Finally, a new long upswing will not necessarily solve the problem of unemployment. The secular trend of technical change in capitalist economies is towards mechanization, which means less labour per unit of output. The present technological revolution is perfectly in line with this broad tendency, which is even becoming more extreme. Of course, the expansion of demand can offset the adverse effect on employment of productivity increases. However, the present situation is characterized by an increasing use of capital goods to produce not only consumer goods but also capital goods. In addition, new technologies are rapidly spreading in the service sector, which up to now has been highly labour-intensive. *Coeteris paribus* it is thus unlikely that, in the medium/long term, the manpower shaken out by technical change will be fully absorbed by the general expansion.

All this emphasizes the necessity to devise ways of reducing the total labour supply. The main area which deserves attention is certainly the reduction of working hours. To be effective, this measure should be sudden, massive and generalized. It goes without saying that this raises a host of problems, chiefly the distributive effect of such a measure. Should the cost be borne entirely by workers, the cost or could wage cuts be less than proportionate to the reduction in working time ?

Although recent experience has shown that a two-digit rate of unemployment does not have the effect of disrupting social structures (as was feared in the sixties), I believe that, on moral grounds, our democracies cannot

afford to neglect the challenge of new, persistent, massive unemployment and offer upcoming generations the prospect of a "two-tier society".

(1) Long waves were studied first as a price phenomenon and subsequently from the point of view of "real" variables. This paper deals solely with the latter aspect.

(2) Nevertheless, the fact that this long wave does not appear clearly from data could simply be due to inadequate statistics. In fact, figures referring to that period are not very reliable and, in addition, they concern one country (U.K) almost exclusively.

(3) For a more exhaustive summary of the empirical evidence see Van Duijn (1983, Chapter IX), Kleinknecht (1986), Screpanti (1984) and Goldstein (1988 : 81-92).

(4) This is for instance the case when, as in Van Ewijk's work (1982), the trend elimination is obtained by using growth rates. As noted by Reijnders (1990 : 237), this procedure not only tends to create "fastard cycles" but also suppresses long term movements and accordingly accentuates short-term fluctuations.

(5) "Technological paradigm" is taken here by analogy with the scientific paradigm in the Kuhn sense, "as a model and a pattern of solution of selected technological problems, based on selected principles derived from natural sciences and on selected material technologies" (Dosi, G, Technological paradigms and technological trajectories. The determinants and directions of technical change and the transformation of the economy, in: FREEMAN, C. editor 1984 : 83). In other words, the technological paradigm refers to "the prevailing engineering and managerial common sense for best productivity and most profitable practice, which is applicable in almost any industry" (Freeman and Perez, 1988 : 48)

(6) The following considerations are inspired by Freeman and Perez (1988 : 47-58).

(7) A distinction should be made between "invention" and its successful introduction on the market as "innovation", because the time lag between the two is sometimes considerable.

(8) Fiat provides a good example of this: in the seventies its economic and financial situation was poor and it managed to overcome this by means of important product and process innovations.

(9) In Mandel's jargon this is an indication of the capital intensity of production. It is measured either as the capital/output ratio or as the ratio of fixed and circulating capital to the stock of capital advanced for wages.

The capital intensity of production should not be confused with the degree of mechanization, represented by the capital/labour ratio.

(10) This indicator can be proxied by the profit/wages ratio.

(11) Screpanti (1984) presented an interesting model showing the influence of social struggles on the upper turning point of the long wave. Dockès and Rosier (1983) go further, putting social conflicts at the core of the dynamic of long waves.

(12) Basic innovation is defined as something that starts a new industry.

(13) The time constants of the innovation waves diminish by the geometric ratio of 1,414; this allowed Marchetti to extrapolate to the fourth long wave.

(14) In fact, the application of a non-parametric test to the frequencies of the whole period shows that the alternation of periods of high propensity to innovate with periods of low propensity is not random.

(15) For another criticism of Mensch's theory see Mansfield (1983).

(16) Kleinknecht's sample was obtained by adding together the sets of innovations by Mensch, Van Duijn and Haustein and Neuwirth (1982), which produced a total of 461 cases of basic innovations. 55 cases were common to the three authors and 80 were reported by two authors only. This introduced an implicit weight to ensure the radical nature of innovations. In fact, the cases reported by the three authors were counted three times; cases included in two of the three sources were counted twice

(17) Kleinknecht's periodization of the economic wave is slightly different from Van Duijn's chronology reported in Table 1.

(18) More generally, Olson (1982) linked the decline of nations to institutional rigidities.

(19) A general definition of "regulation" is provided by the philosopher G. Canguilhem: "la régulation, c'est l'ajustement, conformément à quelque règle ou norme, d'une pluralité de mouvements ou d'actes et de leurs effets ou produits que leur diversité ou leur succession rend d'abord étrangers les uns aux autres".

(20) According to Boyer (1986 : 54-55) this concept designates any set of rules and individual and collective behaviours which have the three following properties:
- they make possible conflicting decentralized decisions compatible

without the necessity for individuals or even institutions to comprehend the logic of the whole system;
- they control and regulate the prevailing accumulation mode;
- they reproduce basic social relationships by means of a system of historically determined institutional forms.

(21) This point is discussed in Reati (1990 : 20-23).

(22) These factors are analysed in Reati (1990), with reference to the last long wave in the main EEC countries.

(23) Here there is an unavoidable ambiguity in the terminology adopted for the phases of the long wave. In this paragraph the business cycle is meant to be composed of two phases:
(a) prosperity, when production accelerates, and
(b) recession, when it slows down.

(24) It is well known that, during the "Golden Sixties", because economists forgot the long waves, they were led to think that the business cycle was "obsolete" in the sense that deep depressions would never happen again. If economies did not sink in the 1970s as they did in the 1930s, it is because of massive intervention by the State to support demand and to help enterprises directly

(25) Dupriez (id. : 255) also quotes A. Aftalion's book of 1914 and W.C. Mitchell's book (1928) in which there is the same observation.

(26) See also P. Dupriez and Ost (1986, : 99-101).

(27) For an opitmistic view on Europe's growth possibilities in the 1990s see Giersch (1990). However, this author's analysis is not based on the long wave mechanism.

(28) For a positive answer see Grübler and Nowotny (1990)

(29) A good example of renewal of old industries is provided by the automobile and textile industries. With the new equipment, the European textile industry could successfully face the competition from the Third World

(30) On all these points see OECD 1989 : 14-15.

(31) This is what Freeman and Perez (1988 : 60) calls "systemation" and "networking" resulting from the information intensive productive organization.

(32) This appreciation of the radical nature of the innovations should be taken as provisional and tentative because, as already noted, it is risky to make a firm judgment when the process is ongoing.

(33) At the beginning of the 1980s, 10% of US copper was extracted via microbial methods (Sharpe 1985 : 170)

(34) This term refers to all the electronic systems used in aircraft, engines, missiles and spacecraft

(35) Experience has shown that, especially in French industry, this element was far from negligible. See Reati 1990, Chapter VII

(36) For a discussion of the statistical definition of profits and related issues see Reati (1990, chapter V).

(37) Note that, in formula 1, value added is net while, in the current measures of capacity utilization, output is gross. However, if the percentage of depreciation is the same for actual and potential output, cu does not change when defined on a net or a gross basis.

(38) In fact, of the three categories of commodities forming the capital stock (machinery, vehicles, constructions) the first two are produced by manufacturing. However, the different evolution of PVA and PK depends not only on the prices of construction but also on the different commodity basket making up the two indices

(39) The only exception is the first cycle (1958-1962) in the USA, in which the length of the prosperity phase was shorter than the recession. However, the amplitude of the prosperity (18.9%) exceeded that of the recession (-11.3%).

(40) It is known that profitability is a leading indicator in the business cycle since troughs and peaks of the rate of profit usually precede troughs and peaks in production (see, for instance, Reati 1983)

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