# AN INTEGRATED MODEL OF CUMULATIVE GROWTH: EMPIRICAL EVIDENCE FOR NINE OECD COUNTRIES, 1960-1990

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# AN INTEGRATED MODEL OF CUMULATIVE GROWTH:
## Empirical Evidence for Nine OECD Countries, 1960-1990*

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*Abstract:* This paper is an empirical analysis of the interaction between the dynamics of demand, productivity and employment in nine industrial countries, viz. the United States, Canada, Japan, West Germany, France, Italy, the United Kingdom, the Netherlands, and Belgium, from 1960-1990.
Its theoretical framework derives from the Kaldorian approach to cumulative growth in both its external and internal causation versions. The model we adopt is of an integrated kind, in which foreign demand is determined endogenously and domestic demand is divided up into its various component parts: exogenous for the public sector and endogenous for the private. More specifically, this is carried out by describing the way the dynamics of private consumption and private investments depend on economic variables located in the spheres of distribution and of technology, so that we can consider the operations of *income compensation effects* induced by technological change - via changes in income and its social distribution - as well as *price compensation effects* - the higher competitiveness of national products in foreign markets - mediated through the dynamics of exports.

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## 0. *Introduction*

The analysis of the interactions between economic growth, technical progress and the dynamics of employment patterns is central to several theoretical and empirical studies deriving from Kaldor's work (Boyer, 1988; Boyer - Petit, 1991; Ralle, 1988), and further interest has been shown in recent years (Amable, 1991, 1992a and b, 1993; Amable - Mouhoud, 1990; Fagerberg, 1988, 1991). In these studies basically two distinct growth models were developed, the "external" and "internal" causation models, with the aim of explaining the medium and long-term dynamics of industrial employment.

In a recent publication of mine (Pini, 1993), the adoption of a cumulative growth model with external causation for nine OECD countries from 1960-1990 was shown to confirm a relationship between the dynamics of productivity and that of demand (production), as the reduced form of a structural model which incorporates important characteristics of the economic systems inherent in the process of capital formation and in the process of innovation. Such characteristics are basic to specific regimes of growth of both productivity and of demand. The analysis also allowed the examination of the role of some important compensation effects induced by the productivity dynamics on employment and mediated by the dynamics of exports.

However, the previous study did not deal directly with other important mechanisms of the reabsorption of unemployment which intervene in the determination of the demand regime, in that in the model of external causation internal demand is dealt with exogenously. The need to take into account income compensation mechanisms mediated through the change in the internal components of demand therefore leads us to apply a cumulative growth model of an integrated kind, in which both external and internal causation mechanisms are present.

This study will therefore try to develop the empirical analysis carried out previously (Pini, 1993), with reference to nine industrialised countries from 1960-1990 (the United States, Canada, Japan, West Germany, France, Italy, the United Kingdom, the Netherlands and Belgium), adopting an integrated cumulative growth model in which, unlike the external causation model previously used, internal demand is divided into its separate components: the public component, exogenous, and the private one, endogenous. In particular, this is carried out by describing the way the dynamics of private consumption and of investments is linked to and depends upon the economic variables located in the sphere of distribution and technology, so that we can examine the workings of the effects of income compensation induced by technological change.

## 1. Stylized facts and theoretic explanations

In recent years the problem of employment in industrialised countries, together with the related problem of unemployment, is once again of central importance to economic analysis. This has also happened as a result of the effects on the labour market both of the economic crisis of the end of the eighties and the beginning of the nineties, and of the structural changes which have taken place in industrial systems in an international context, which has seen the emergence in international markets of newly industrialised, highly price competitive countries (CEC, 1992; OECD, 1993b).

With reference to the recent dynamics of the labour market in industrialised countries certain stylized facts should be taken into account (Bean, 1992).

First of all, the "equilibrium" rate of unemployment corresponding to a constant inflation rate appears to have substantially increased over the last two decades. Secondly, among those countries which experienced similar inflation levels in the seventies, the stabilisation process of the countries of Europe stands out for its higher rates of unemployment and at the same time, when the stabilisation of inflation has been reached, the rate of unemployment has not gone down. Thirdly, this dynamics has also been associated with the reduced chances of finding a job and the increased chances of losing one, resulting in a substantial increase in long-term unemployment. This has led to a growth in unemployment of the persistent type, especially for some categories of the labour force. Finally, a further stylized fact that appears to characterise the labour market of EC countries in particular is the shift in the relationship between unemployment and vacancies, which shows a constant growth in the level of equilibrium of unemployment in relation to a given quantity of vacancies.

In order to explain these stylized facts various analyses (Bean, 1992; Drezè - Bean, eds., 1990) have stressed the role played by stabilisation policies aiming to reduce inflation and also changes in the terms of trade between various countries. Such factors, however important in determining higher rates of unemployment, do not help to explain the persistent character of unemployment. The importance of the institutional regime which characterises the different labour markets has been suggested to this purpose. And in this context the adjustment mechanisms within markets which appear to be insufficiently flexible have been highlighted.

The theoretical analysis, but above all the construction of the models adopted in the empirical analysis, are based on a framework made up of a combination of microeconomic analysis of the functioning of the labour market and macroeconomic analysis centred on the existence of non-competitive market forms in both the goods market and the labour market (Layard - Nickell - Jackman, 1991). The various wage-bargaining regimes, and the ways these are affected by the operation of the primary and secondary labour markets, by the characteristics of the income support systems and by the effort function of the worker in the workplace[1], have all found a central place in the explanation of unemployment and its persistent nature. It has thus been based mainly on the analysis of factors which affect the structure of the supply side of the labour market.

These analyses, however, provide not adequately an explanation of the medium and long-term dynamics of industrial employment and unemployment. In particular, they neglect one important factor which intervenes in the relationship between production and employment, namely the productivity dynamics[2]. This limitation lies not only in the lack of attention paid to technological change in the growth process of economic systems, but also in the absence of analysis of the interactions between demand growth and productivity growth, thereby relegating the role of demand solely to a factor in the explanation of the phases of economic cycles. This makes it difficult to examine the various components of unemployment, leading to an identification of the latter essentially with unemployment of a structural kind, caused by the prevailing wage-bargaining regime.

Recent studies, on the other hand, have shown the emergence of an important change in the dynamic relationship between volume of production and volume of employment (OECD, 1991b)[3]. Though they confirm a strong, direct causal connection between the first and second variable when a fall in production is occurring, such a connection does not appear in the phases in which production increases. While economic growth in the fifties and sixties went with high rates of production growth, almost full employment and considerable and widespread product innovation, the growth regime of the seventies and eighties featured low growth rates, low employment intensity, and pervasive process innovation. There is ample and convincing empirical evidence to show that in circumstances favorable to growth, employment volume did not necessarily increase[4]. For the industrial sectors, in particular, the restructuring processes (both in terms of organisation and technology) which were carried out in the periods of crisis meant irreversible changes, which inhibited a recovery in employment in periods of growth[5].

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1 In particular, we refer here to the role of insider and outsider workers, to the unemployment benefit system, and to the determination of efficiency-wages.

2 In some work the effects of productivity dynamics on the dynamics of unemployment have been explicitly excluded in the long run: "[...] there are very powerful mechanisms at work which have forced the number of jobs to respond to huge changes that have occurred in the numbers of people wanting jobs. It also suggests that in the long run productivity and taxes have no impact on unemployment" (Layard - Nickell - Jackman, 1991, p. 5).

3 See also the papers presented at the recent OECD conference on "Technology, Innovation Policy and Employment", 7-9 October 1993, Helsinki, organized within the "OECD - Employment/Unemployment Task Force, 1993-1994" (OECD, 1993a).

4 This is particularly true for the industrial sectors of the economy - which is nothing new. But there are also robust indications that that is also true for the service sectors - which has not previously been found in industrial systems.

5 At the same time, in the different service sectors, tradeable and non-tradeable, those mechanisms which in the past, in terms of employment, permitted compensation for the loss of jobs in the secondary sector,

As table 1 and figures 1 and 2 show, the relationships between growth in demand, in productivity and employment in the industrial sectors of nine OECD countries vary both for the countries and the time spans involved. There is not only an evident weakening of the causal connection between demand and productivity, but also profound changes over time and significant differences between countries above all in the relation between demand and employment.

The theoretical framework of this study consists precisely in those interrelationships between demand growth and productivity growth which emerge in cumulative growth models deriving from Kaldor's work (Kaldor, 1966, 1981; Thirwall, 1986). On the basis of previous analysis (Boyer - Petit, 1981, 1988; Pini, 1993), it will try to find explanations for the medium and long term dynamics of industrial employment in a significant number of countries, using a cumulative growth model which incorporates both internal and external causation mechanisms.

This is proposed as an integrated model of the two well-known models identified as "internal causation" and "external causation". The former is based on identifying the factors of internal demand which set off the process of cumulative growth and influence the medium-term growth path. In this area we pay special attention to the income distribution determinants of the dynamics of investment and of internal consumption[6]. The latter is based on the identification of the driving role of export dynamics which, given the dynamics of the internal components of demand, are positively affected by increases in productivity[7,8].

## 2. *An integrated model of cumulative growth*

The structure of the integrated cumulative growth model is based on the two elements which are essential to the class of growth models deriving from Kaldor: a causal link of a Keynesian kind between growth in demand and growth in production; and a process of interaction between growth of demand and growth of productivity.

The latter is developed through two distinct causal sequences. On the one hand we presuppose the existence of Kaldor-Verdoorn returns to scale with which the presence of a causal connection which leads from a growth in demand to a growth in productivity is

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seem to have seized up.

6 See for all these Boyer (1988) and the works cited.

7 See Cripps - Tarling (1973) e Boyer - Petit (1981, 1988).

8 The model employed here incorporates some of the main characteristics of the cumulative growth models developed by the theory of regulations, in particular some of those aspects related to the technological paradigm, to the accumulation regime and to the regulation modes in its distributive aspects, while it neglects the institutional modes specific to the labour market. For a more complete estimate of aspects not considered here see Lordon (1992), Leborgne - Lepietz (1988) and Boyer (1993).

made explicit, mainly by means of the process of capital formation. On the other hand, that same productivity growth determines growth in demand, both via the positive influence that the former has on exports by raising the price competitiveness of national products on foreign markets, and by means of its effects on the internal components of demand induced by the growth of real incomes and the change in their distribution between various income categories, mainly the profit earners and wage earners.

In the specification of the link which connects productivity growth to growth in demand, the integrated cumulative growth model thus incorporates both the external and internal causation mechanisms suggested in the Kaldorian studies of the French school of regulation (Boyer, 1988; Boyer - Coriat, 1987; Boyer - Petit, 1981, 1988, 1991; Ralle, 1988)[9].

The external causation mechanism is based on the medium- and long-term dynamics of the foreign component of the aggregate demand, exports. These are influenced both by external exogenous factors such as the evolution of foreign markets and the price and non-price competitiveness of foreign goods, and by internal factors, exogenous and endogenous, such as the dynamics of the exchange rate and productivity gains (in so far as they appear in the shape of changes in internal prices rather than in variations in nominal income). The latter affect the terms of trade and thus the competitiveness of national products on foreign markets, besides the results of the innovation process, which influence the non-price competitiveness of national products.

The core of the internal causation mechanism lies in the way the various components of aggregate demand, mainly private consumption and private investments, are stimulated by the growth in real incomes and by the changes in their social distribution which follow from productivity increases. As a matter of fact, the benefits of technical progress are distributed between the various social classes of the economic system affecting the growth paths of aggregate demand and its distinct components, investments and consumption. Investments depend on the dynamics both of aggregate demand, presupposing the operation of the Keynesian accelerator principle, and of profits, on the basis of a classical accumulation mechanism. Consumption, on the other hand, is defined by adopting a behaviour hypothesis which is not strictly classical: it depends mainly on the overall income of the workers and therefore on the dynamics of real wages and of employment, without however excluding an influence of the consumer decisions of the profits earners. The dynamics of real compensations is in turn determined on the basis of a competitive market mechanism and/or of a distributive mechanism of the benefits of technical progress, and is therefore affected both by the degree of pressure of demand on the labour market and by the productivity dynamics. In its turn, the profit dynamics is itself affected

[9] For an analysis and critical evaluation of the model of cumulative growth with external causation see Pini (1992, Ch. 3.4).

by increases in productivity through the distribution mechanism of the benefits of technical progress and also of the actual growth of the value added, according to a mechanism of the Keynesian kind.

In the Kaldorian approach to the cumulative growth model, technological change takes on an essential role in the determination of the dynamics of production, demand and employment. The intensity, bias and results of the innovation process, together with the operation of dynamic returns to scale, not only trace the growth path of labour productivity with its consequent effects on the dynamics of employment given the volume of output, but also set off important compensation mechanisms which are both external (stimulating the export dynamics) and internal (affecting real incomes, their distribution, and therefore the internal components of aggregate demand, private consumption and private investments).

The cumulative growth model with external causation can be illustrated in the following block diagram (Fig. 3) and by the following model of simultaneous equations (eq. (1)-(10)). In this scheme, demand growth and productivity growth interact through two distinct sequences determining the demand regime and the productivity regime and together they determine the dynamics of employment.

The sequence identifying the productivity regime develops from demand growth to productivity growth. In this model, productivity gains derive from the accumulation process which explains the investment ratio (*ir*) (eq.(2)): the latter depends on the growth rate of value added (*q*), so that the role of dynamic returns to scale is captured, and on specific input variables concerning innovation activity (*inno-input*). The investment ratio, then, contributes to the determination of the dynamics of employment (*e*) (eq.(1)), together with the growth of industrial value added, and the dynamics of machinery and equipment investments (*me*) with the aim of capturing a specific direction of technical progress. These do not necessarily have negative effects on employment, for in this equation this variable should capture the technological multiplier effects in the production phase of these capital goods, while the substitution effects in their utilization phase should be captured by the investment ratio. The previous equations, together with the identity represented by equation (10), identify the productivity regime, that is the causal relation which leads from demand to productivity (PR). Such a relationship is formally identical in a model of this kind to the one located in the context of the external causation model of cumulative growth (Pini, 1993).

(1) $e = f_1(ir, q, me)$,

(2) $ir = f_2(q, \mathit{inno\text{-}input})$,

(3) $q = f_3(x, pc, pi, ge)$,

(4) $x = f_4(pr, er, me, \mathit{inno\text{-}output})$,

(5) $pc = f_5(wb, os)$,

(6) $pi \quad = f_6(os, q)$,

(7) $rw \quad = f_7(pr, ur)$,

(8) $os \quad = f_8(pr, q)$,

(9) $wb \quad = rw + e$,

(10) $pr \quad = q - e$.

Determining the demand regime turns out to be more complex than is the case with the external causation model of cumulative growth. In fact, while in the external causation model, internal demand was exogenous, in the integrated model, as can be seen from equation (3), internal demand is divided into three components: government expenditure (*ge*), private consumption (*pc*), and private investments (*pi*), of which the last two are endogenous. Components such as these, together with the foreign component ($x$), determine the trend in industrial value added, thus displaying one of the Keynesian characteristics of the model, in which a causal link is assumed which leads from demand, in its various components, to value added. Exports depend on the productivity dynamics, on the exchange rate (*er*), on the investments in machinery and equipment, and on the output variables of the innovation activity (*inno-output*) (eq. (4)). These variables help to determine the price and non-price competitiveness of national products on foreign markets. On the other hand, the dynamics of the endogenous internal components of demand are the result of more complex dynamic interactions between demand, productivity and distribution, with the aim of including the effects of productivity increases on internal demand, and thus the effects of income compensation neglected in the external causation model. It is in this area that the originality of the integrated model lies, when compared to the external causation model. While the dynamics of private consumption (eq. (5)) is determined by the pattern both in the incomes of wage earners (*wb*) and profit earners (*os*), without placing undue emphasis on spending behaviour of the classical kind which just sees the workers consume, the dynamics of private investments (eq. (6)) is affected on the one hand by the demand dynamics, incorporating the Keynesian accelerator principle, and on the other by the profit dynamics on the basis of assumptions of a classical type. After defining the pattern of wage earners' incomes (eq. (9)) as the sum of the growth rates of industrial employment and real wages (*rw*), the latter is endogenously determined by the operation of two distinct mechanisms: a mechanism that brings out the distribution of the benefits of technical progress, and therefore of how productivity increases are translated into increases in real wages; and a mechanism of the competitive type on the labour market located by the relation between the rate of unemployment and the dynamics of real wages. With reference to the second distributive component, the profit earners' income, it is assumed that it also answers to two distinct mechanisms (eq. (8)). The first, in a similar way to the determination of the real wage, concerns the distribution of the benefits of technical progress, and therefore of the productivity increases on the profits dynamics. The second, on the other hand, assumes a positive relation between the latter and the dynamics of the industrial value added. In a scheme of this kind, therefore, the causal link leading from productivity increases to the dynamics of the incomes of the two social categories considered, wage earners and profit earners, and the ways in which the private components of internal demand answer to such changes in distribution, turn out to be crucial. The relations contained in the equation (3)-(8) and the identities represented by equations (9)-(10) allow us to locate the demand regime.

Briefly, the equations for the productivity regime (PR) and for the demand regime (DR) are the following:

$$\text{(PR)}\ pr = g(C_{pr}, q, x_j),$$
$$\text{(DR)}\ q = h(C_q, pr, x_i),$$

where $x_j$ represent the exogenous variables contained in the employment and the investment ratio equations, $x_i$ represent the exogenous variables contained in the demand equations, and $C_q$ and $C_{pr}$ the possible constants present in the behaviour equations, for the demand and productivity regimes respectively[10].

3. *An empirical verification model*

The model adopted for empirical analysis for the hypothesis of linearity both in parameters and in variables is represented by the following ten simultaneous equations, the last two of which are identities[11]:

$$(11)\ \mathrm{EIG}_t = e_0 + e_1\mathrm{ISY}_t + e_2\mathrm{VAIG}_t + e_3\mathrm{MEG}_t + u_{et},$$
$$(12)\ \mathrm{ISY}_t = i_0 + i_1\mathrm{VAIG}_t + i_2\mathrm{ISYJ}_t + i_3\mathrm{INNO\text{-}INPUT}_t + u_{it},$$
$$(13)\ \mathrm{VAIG}_t = v_0 + v_1\mathrm{EXPG}_t + v_2\mathrm{PCG}_t + v_3\mathrm{PFIG}_t + v_4\mathrm{GCG}_t + u_{vt},$$
$$(14)\ \mathrm{EXPG}_t = x_0 + x_1\mathrm{ILPG}_t + x_2\mathrm{EEXRG}_t + x_3\mathrm{MEG}_t + x_4\mathrm{INNO\text{-}OUTPUT}_t + u_{xt},$$
$$(15)\ \mathrm{PCG}_t = c_0 + c_1\mathrm{WBG}_t + c_2\mathrm{OSG}_t + u_{ct},$$

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10 The stability condition for the integrated cumulative growth model is the same as that concerning the external or internal causation model: the elasticity of productivity growth with respect to demand growth should be less, in absolute value, than the inverse of the elasticity of demand growth with respect to productivity growth, that is:

$$\partial pr/\partial q = g'_2 < 1/(\partial q/\partial pr) = 1/h'_2.$$

11 See the Abbreviations for a definition of the variables.

$$
\begin{aligned}
&(16)\ PFIG_t &&= s_0 + s_1 OSG_t + s_2 VAIG_t + u_{st},\\
&(17)\ RWG_t &&= w_0 + w_1 ILPG_t + w_2 UR_t + u_{wt},\\
&(18)\ OSG_t &&= p_0 + p_1 ILPG_t + p_2 VAIG_t + u_{pt},\\
&(19)\ WBG_t &&= RWG_t + EIG_t,\\
&(20)\ ILPG_t &&= VAIG_t - EIG_t,
\end{aligned}
$$

whose solution leads to the determination of the ten endogenous variables EIG, VAIG, ISY, EXPG, ILPG, PCG, PFIG, RWG, WBG and OSG, given the seven exogenous variables MEG, ISYJ, INNO-INPUT, GCG, EEXRG, INNO-OUTPUT and UR [12,13,14].

From the equations (11) - (20), the following equations relating to the productivity regime (21) and demand regime (22) can be obtained:

$$
\begin{aligned}
(21)\ ILPG_t = {} & - (e_0+e_1 i_0) + (1-e_2-e_1 i_1) VAIG_t - (e_1 i_2) ISYJ_t + \\
& - (e_1 i_3) INNO\text{-}INPUT_t - (e_3) MEG_t + u_{I,t},
\end{aligned}
$$

$$
\begin{aligned}
(22)\ VAIG_t = {} & (v_0+v_1 x_0+v_2 c_0+v_2 c_1 w_0+v_2 c_2 p_0+v_3 s_0+v_3 s_1 p_0)/D + \\
& + [(v_1 x_1+v_2 c_1 w_1-v_2 c_1+v_2 c_2 p_1+v_3 s_1 p_1)/D] ILPG_t + \\
& + [(v_1 x_2)/D] EEXRG_t + [(v_1 x_3)/D] MEG_t + \\
& + [(v_1 x_4)/D] INNO\text{-}OUTPUT_t + [(v_4)/D] GCG_t + \\
& + [(v_2 c_1 w_2)/D] UR_t + u_{II,t},
\end{aligned}
$$

where $D=(1-v_2 c_1-v_2 c_2 p_2-v_3 s_1 p_2-v_3 s_2)$, from which the following stability condition derives:

$$
(23)\ \ (1-e_2-e_1 i_1) < 1/[(v_1 x_1+v_2 c_1 w_1-v_2 c_1+v_2 c_2 p_1+v_3 s_1 p_1)/D].
$$

The model used for empirical verification allows us to identify various important effects brought about by technological change on the dynamics of employment, effects both of the direct type given production and demand, and of the indirect type mediated mainly through the interactions between the dynamics of productivity, of demand, and of income distribution which may turn out to be compensatory with respect to the initially negative impact.

The direct effect is mainly caught by the coefficient $e_1<0$ relative to the variable

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[12] The analysis of the model shows how all the behaviour equations are overidentified, as both the order and rank conditions for the simultaneous models are satisfied.

[13] With reference to the errors, we can assume that these are distributed with the zero mean and constant variance-covariance matrix.

[14] The ISYJ variable is a dummy for the investment ratio of Japan, which is around 10 percent points higher than those of the other countries for the entire period examined.

ISY in the employment equation, and therefore indirectly by the coefficients $i_1>0$ and $i_3>0$ relative to VAIG and INNO-INPUT in the investment ratio equation. While these coefficients help to capture the effect of the substitution of labour brought about by the utilisation of new capital goods which add to productivity, the multiplier effect of technology brought about by the production of new capital goods can on the other hand be caught by the coefficient $e_3>0$ relative to MEG in the employment equation.

The effects of price and income compensation operate through the export dynamics and the dynamics of the private components of internal demand. In the export equation (eq. (14)) the coefficients $x_1>0$, $x_3>0$ and $x_4>0$ relative to ILPG, MEG and INNO-OUTPUT are intended to catch the effects brought about by the greater price and non-price competitiveness of the national product on foreign markets which are the result of technical progress, from which follow the positive effects of exports on value added (with $v_1>0$ in the eq. (13)) and the compensation effects of value added on employment (with $e_2>0$ in the eq. (11)). With reference to the endogenous components of internal demand, the income compensation effects are caught by various coefficients which concern different forms of compensation: above all the dynamics of private consumption ($v_2>0$ in the eq. (13)) which is primarily affected by the dynamics of the income of employees ($c_1>0$ in the eq. (15)). In this case a compensation mechanism activated by the transfer of productivity increases to real wages is in operation ($w_1>0$ in the eq. (17)). In any case it is necessary to take into account the effect produced by the employment dynamics, given the productivity increases, on the wage bill, since the latter is the result of the joint dynamics of real wages and the volume of employment. It may turn out to be either positive or negative according to whether the productivity increases add to or reduce industrial employment. Furthermore, compensation effects can also be produced through consumption growth sustained by profit earners ($c_2>0$ in the eq. (15)), and this calls into play the mechanisms that control the determination of incomes of this kind (eq. (18))[15,16]. The spending decisions of the profit earners turn out, however, to be central in the determination of the other endogenous component of internal demand: the investments

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15 The examination of such mechanisms and of the coefficients that concern them is carried out later in relation to the compensation effects brought about by the growth of investments.

16 In the determination of consumption an indicator of product innovations which stimulates the dynamics of such a demand component could be directly relevant. In the model developed by Vivarelli (1992) for a closed economy this is taken into consideration. In this work, a specific indicator of process innovations in the productivity and price equations are also utilised, as well as R&D expenditure in the investments equation.

However, the indicators adopted for product innovations and process innovations and the way in which they have been constructed, starting with R&D expenditure and with the Italian patents registered on the U.S. market, would not seem to be particularly convincing. On the other hand, not even the variables we identify as indicators of the results of innovation activity (PAT-ASR, PAT-CMPR, BTCR, and HTGEIR) seem to us especially suitable as indicators of process innovations or product innovations. We have thus chosen a specification that only takes into consideration the incomes dynamics, leaving the task of capturing the effects produced by these factors to the constants.

($v_3$>0 in equation (13)). In this case, the coefficients that capture the compensation mechanisms are $s_1$>0 for OSG and $s_2$>0 for VAIG in equation (16) which concern the compensation effects brought about respectively by: a) the process of profit accumulation deriving from the transfer of the productivity increases ($p_1$>0 in equation (18)) or by the growth of the value added ($p_2$>0 in the eq. (18)); b) by the operation of the Keynesian accelerator principle.

With the aim of capturing the previously indicated effects, the model specified in the structural form shown in the equation (11)-(20) was used in the empirical analysis concerning nine industrial countries (West Germany, France, Italy, the United Kingdom, Belgium, the Netherlands, the United States, Canada and Japan) from 1960 to 1990. The statistical documentation is similar to that used previously (Pini, 1993), with the addition of the data for the variables introduced here whose source is once again OECD[17].

## 4. *Empirical Analysis*

The results of the econometric estimates of the integrated cumulative growth model would appear to confirm the interrelation between growth in demand, productivity and employment which develop through the operation of cumulative growth mechanisms of the external type, based on the dynamics of exports, and of the internal type, concerning the domestic components of aggregate demand, the income distribution channels and the sharing of productivity gains[18,19].

First of all it should be noticed that both the causal links which lead from demand to productivity (productivity regime) and from productivity to demand (demand regime) are confirmed by the estimation of the M1-I - M4-I models, which are different as far as the output variable of the innovation process utilised is concerned (tables R1-I - R4-I). With reference to the productivity regime, the link between the growth of value added, of

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17 For the presentation of the statistical documentation used and the construction of the database over the cycle, see Pini (1993, §.4).

18 For reasons of space, in the tables which follow, the estimated values of the coefficients are shown without the indications of the Student's t. The coefficients should be understood to be significantly different from zero at the 95% level of confidence, with the exception of the cases indicated with an asterisk.

19 It should be noted that, regarding the external causation cumulative growth model estimated by Pini (1993) in which the domestic demand growth was exogenous, the results for the exogeneity tests for the variable IDG in the value added equation do not seem entirely conclusive. In fact, using the specification test suggested by Hausman (1978) and based on the estimates obtained by the 3SLS and 2SLS methods the hypothesis of exogeneity is rejected at the 90% level of confidence, but not at the 95% level of confidence ($Chi^2$=2.74, DF=1), while using a different version of the test suggested by Spencer - Berk (1981) based on the estimates obtained by 2SLS and IV methods where IDG is not included in the instrumental variables, the hypothesis of exogeneity is rejected only at the 50% level of confidence ($Chi^2$=0.65, DF=1). For the exogeneity tests used see Green ($1993^2$, Ch 20.5).

industrial employment and the investment ratio, and between the latter and the growth of industrial employment, would appear to be confirmed. If on the one hand the value added confirms its positive influence on the pattern of employment[20], on the other, through the investment ratio, it has a negative influence on the employment dynamics[21]. The latter, still through the investment ratio, is also negatively affected by the dynamics of expenditure in R&D[22]. With reference to the demand regime, the compensation mechanisms of the negative effects of productivity growth on employment, given demand, would seem to be robust both in the external and the internal components of demand. Export growth is stimulated by the productivity increases and by the results of the innovation activity represented by the output variable of the innovation process[23]. The consumption[24] and investment dynamics are positively affected by productivity growth through the positive effects this has both on the income of employees and on operating surplus[25].

The important role played by the input and output variables of the innovation process are also confirmed. With reference to the productivity regime, expenditure in R&D has quite important (positive) effects on the investment ratio and similarly important (negative) effects on the dynamics of employment[26]. The effect on the productivity regime

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[20] The high explanatory power for value added in the employment equation for the Model 1-I (the partial coefficient of determination is 0.49) should be noted.

[21] For the Model 1-I, the explanatory power of the investment ratio in the employment equation is quite high (partial coefficient of determination 0.51), while that referring to the value added in the investment ratio equation is much lower (0.17).

[22] However, it is necessary to notice this while that is true with reference to the productivity regime, the overall effect of R&D expenditure on the employment dynamics does not turn out to be particularly significant, insofar as they influence both the growth of the value added and that of productivity in similar ways, with negligible effects on employment. See the estimated coefficients of the reduced form.

[23] In this case, the partial coefficient of determination in the export equation is 0.65 for ILPG and 0.10 for the *inno-output* variable (Model 1-I).

[24] With reference to the possible effect exercised by product innovations on the consumption dynamics (see note 16) a model has been estimated in which the private consumption equation also includes the variable NPATG (growth rate of national patents applications) as a proxy for product innovation. The estimated coefficient is not statistically significant, and the specification tests W, LM, LR, and F conducted on the inclusion of such a variable do not suggest that the unrestricted model (with NPATG) is superior to the restricted one (without NPATG). This result confirms what was seen previously (note 16), so that we have preferred to continue with the estimate of the specified model without product innovation in the private consumption equation. On the other hand the proxy employed (NPATG) cannot easily be interpreted as an indicator of product innovation, including as it does all the patent applications both for process innovations and for product innovations. These considerations applied also to NPATRPOPG.

[25] Productivity shows a satisfactory explanatory power in the compensation equation (the partial coefficient of determination is 0.26 for the Model 1-I), while its explanatory power is lower in the operating surplus equation (0.14).

[26] In this model expenditure in the R&D variable is treated as an exogenous variable. Theories on innovation processes and empirical studies have shown, however, that R&D expenditure also depends on variables of an economic type at the company and industry level as well as on exogenous factors in the strictly economic sphere. In our model it could therefore be considered endogenous. The results of the exogeneity tests carried out on the R&DGP variable in the investment ratio equation would not appear to be entirely conclusive as far as their exogeneity is concerned. In fact, using the specification test

is hence positive, overall. With reference to the demand regime, the different variables of output of the innovation process turn out to be a stimulus to export growth and therefore to value added and to employment, compensating in this way the previous negative effect of the input variable. Such conclusions therefore confirm the results arrived at in the context of the external causation model of cumulative growth. Vice versa, as far as the investment in machinery and equipment variable goes, the estimate of the integrated cumulative growth model would not seem to confirm the conclusions obtained with the external causation model. Both the estimated coefficients of the variable used in the employment equation and in the export equation (the growth rate in investment in machinery and equipment) turn out to be very slight[27], that of the employment equation in particular appearing to be insignificant. The assumption of a considerable multiplier effect of technology through the production of such capital goods and captured by this variable would therefore not seem to find confirmation[28].

The estimated model and its derived reduced form also permit the identification of the specific effects on employment, demand and productivity of a change in exogenous variables. As regards model 1-I (Table R1-I) it can be seen that a one percent increase in government consumption leads to increases both in employment (+0.545) and in productivity (+0.455), with widespread effects on overall production (+1.0001). Negative effects, although not very great, are due to a appreciation of one percent in national currency (-0.12 on employment, -0.101 on productivity and -0.221 on production). As regards technological variables, an increase in expenditure in research and development of one percent results in a small, and not vary significant decrease in employment of -0.001, due to higher growth in productivity (+0.027) compared to production (0.026), both of which, however, are low. The effects of a one percent growth in the auto-sufficiency ratio (domestic patent applications over national patent applications) are on the other hand

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suggested by Hausman (1978) and based on the estimates obtained by the 3SLS and 2SLS methods the hypothesis of exogeneity can be rejected only at the 10% level of confidence ($Chi^2$=0.081, DF=1), while using a different version of the test suggested by Spencer - Berk (1981) based on the estimates obtained by 2SLS and IV methods where R&DGP is not included in the instrumental variables the hypothesis of exogeneity is rejected at the 95% level of confidence ($Chi^2$=3.55, DF=1). For the exogeneity tests used see Green (1993[2], Ch. 20.5).

[27] The estimated value is much lower than that obtained for the model with external causation M1 (0.16 for both the coefficients in the two equations considered).

[28] The lack of significance of the coefficient concerning MEG in the employment equation could also be due to the collinearity that this variable presents with VAIG (of which it is a component). In fact the correlation coefficient between these two variables is certainly significant, although not particularly high (table CR). However, the use of other indicators such as the share of investment in machinery and equipment out of the total of fixed investment, MESI, or else the variation rate of this share, MESIG, does not provide different results: in these cases too the estimated coefficients are not significant (the related estimates of the models are not included here for reasons of space). Because of such results, the caution we had already used in commenting on the empirical evidence obtained with the external causation model (Pini, 1993, n.17) in relation to this variable would seem in retrospect to be fully justifiable.

positive for employment (+1.147), with a higher effect on production (+2.101) than on productivity (+0.955). In addition, as we have noted, the effect of a one percent rise in investment in machinery and equipment is not clear: positive on employment (+0.017), but negative both on production (-0.041) and productivity (-0.058), although all the coefficients are not significantly different from zero. Finally, an increase of one percentage point in the unemployment rate has negative effects on all the variables considered: employment decreases (-0.21), as the result of a decrease of value added (-0.385) higher than the decrease in productivity (-0.175).

Some significant differences emerge when the results obtained by the integrated model (Model 1-I), in which the internal demand is endogenous, are compared with the external causation model (Model 1) (Pini, 1993).

If we concentrate on the elasticity of the productivity regime and of the demand regime, it is clear that the first coefficient is not substantially dissimilar in the two models, whereas the second is significantly different.

In the integrated model the productivity regime is marked by a coefficient equal to 0.45, whereas in the estimate for the external causation model it was equal to 0.59. This lower figure depends on a higher coefficient $e_2$ (greater positive effects of value added on employment) not compensated for by a slightly less high coefficient $i_1$ (less positive effects of value added on the investment ratio), whereas the coefficient $e_1$ turns out to be very similar in the two models. The difference of these values explains the lower elasticity of the productivity regime met with in the integrated model. At the same time the similarity of the estimates obtained for the two models would seem to be a confirmation of the strength of the results obtained with reference to the determination of the relations concerning the productivity regime.

This conclusion on the other hand would not seem to be valid when we turn to the demand regime. Here the elasticity of the demand regime is substantially higher in the integrated model (0.98) when compared to the external causation model (0.47). In fact the integrated model allows us to capture endogenous growth mechanisms which are absent in the external causation model, and which are mediated by the effects of the productivity increases on the real income growth of the social classes referred to, the wage and profit earners, on the alteration of their distribution between these two categories and on how this influences the pattern of the endogenous components of demand, private consumption and investments.

In particular, the private consumption component is considerably affected by the dynamics of the total compensations of the employees, and to a considerably lesser extent, by the dynamics of the operating surplus[29]. The investments component in its turn is

[29] The explanatory power of the first variable is much higher than that of the second variable (the partial coefficients of determination are respectively 0.64 and 0.15, for the Model 1-I).

positively influenced both by the growth of value added and by the growth of the operating surplus, even if this latter variable has less influence compared to those of the first variable[30]. In this case therefore there is confirmation of the presence of a strong leading influence on investments of the value added growth in comparison to the role played by the profits dynamics, which would seem to suggest that a Keynesian-type regime prevails over one of a classical type, even if the latter is by no means insignificant. With reference to the sharing of the productivity increases over incomes, the results obtained show a significant link between productivity growth and the growth of real earnings per person employed, on the one hand, and productivity increases and growth of the operating surplus on the other[31]. Sharing mechanisms of productivity gains for both income categories would thus seem to emerge, without any particular "bias" in favour of either category. Moreover, the degree of competitiveness of the labour market would seem to take on a significant role in the determination of the earnings dynamics, as can be seen by the effects created by the rate of unemployment variable[32,33]. In this sense the presence of a regime of the classical kind on the labour market cannot be ruled out. Finally, there is evidence that the operating surplus dynamics is not just influenced by productivity growth but also by the value added growth, albeit less so.

The results arrived at with reference to the demand regime would therefore appear to indicate the presence of specific internal causation mechanisms which sustain growth, as well as the external causation mechanisms sustained by exports, which have already been mentioned. Wages increase with the growth of productivity, and if this favours the total wage bill (because of the only slight negative effects of productivity on employment given value added) consumption rises and hence also the value added, which in its turn sustains the growth of investments. The latter are also stimulated by the growth of profits brought about by the growth of productivity, but more so by the growth of value added. A demand regime would appear to emerge which stresses the distribution of productivity gains both to wages and profits, with Keynesian features in the growth regime, which

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30 This is confirmed by the values of the partial coefficients of determination: that of the value added is higher (0.30) than that of the operating surplus (0.11) (Model 1-I).

31 In the estimated equations of the real compensations for employee and of the operating surplus the productivity variable coefficients are highly significant and their explanatory power is quite satisfactory (the partial coefficients of determination are 0.26 and 0.14 respectively).

32 The explanatory power of this variable is high in the equation of the real compensations for employee (the partial coefficient of determination is 0.44), and higher than that referring to productivity gains (0.26).

33 With respect to the exogeneity of the unemployment rate in this equation, the tests do not seem to reject the hypothesis of exogeneity. In fact, using the specification test suggested by Hausman (1978) and based on the estimates obtained by the 3SLS and 2SLS methods the hypothesis of exogeneity can be rejected only at the 10% level of confidence ($Chi^2$=0.087, DF=1), while using a different version of the test suggested by Spencer - Berk (1981) based on the estimates obtained by 2SLS and IV methods where UR is not included in the instrumental variables the hypothesis of exogeneity can be rejected only at the 25% level of confidence ($Chi^2$=0.36, DF=1). For the exogeneity tests used see Green (1993[2], Ch. 20.5).

however do not rule out the additional presence of a regime of a classical kind on the labour market and in the determination of the investments dynamics.

As regards the analysis of possible structural breaks, for groups of countries, EC and NON-EC, and the periods, 1960-1976 and 1976-1990, stability tests have been carried out for Model 1-I. These tests seem to suggest that the behaviour of the model differs amongst groups of countries and periods. In particular, for groups of countries the equations 1, 2, 4, 6, and 8 present a relative instability[34], while for periods to the previous equations the equations 5 and 7 should also be added[35] (tables R1C, R1P, ST).

First of all the different way the model behaves for the two groups of countries, EC and NON-EC, should be considered. In particular, as far as the productivity regime is concerned, it shows a lower coefficient of productivity elasticity with respect to demand variations for the EC countries compared to NON-EC countries[36] (0.62 against 0.8) (Chart 1).

Going into more detail, the negative effects of the investment ratio on employment are greater in EC countries as compared to NON-EC countries (employment equation). To this has to be also added the greater effects of the value added on the investment ratio in the former compared to the latter (investment ratio equation), in part compensated for by the lesser effects of R&D expenditure. Taken as a whole the negative direct effects on employment brought about by the investment ratio dynamics are greater in EC countries than in NON-EC countries. Such effects are partly compensated for by the relatively greater sensitivity of employment to value added in EC countries compared to NON-EC countries (employment equation).

With reference to the specific effect of the input and output variables of innovation activity, it must be noted that in NON-EC countries both these variables in the investment ratio equation and in the exports equation have a more important effects than in EC countries, and this is the case above all for the output variable of innovation activity. In particular, taking into account also the role of the investment ratio in determining employment, in the integrated causation model too there is confirmation that while the input variable has important negative effects on employment in EC countries, compared to NON-EC countries, the output variable in EC countries does not bring out significant compensation effects on employment (through exports) when compared to NON-EC

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34 The F test would appear to reject at the 99% level the restricted model for the employment and the export equations, while the investment ratio and the operating surplus equations seem unstable adopting stricter criteria, such as the Theil and Akaike criteria.

35 The F test seems to reject, at the 99% level of confidence, the restricted model for the employment, exports and operating surplus equations, for the real compensations for employees at the 95% level, while for the other equations (investment ratio, private consumption, private investments) the restricted model is rejected, adopting stricter criteria, such as the Theil and Akaike criteria.

36 A similar result was obtained for the cumulative growth model with external causation (Pini, 1993, §.5).

countries.

If we move to the demand regime, the results demonstrate a higher coefficient of demand elasticity with respect to productivity variations for EC countries compared to NON-EC countries (0.87 against 0.76), in a similar way to what was found for the external causation model (Pini, 1993, .5) (Chart 1).

Significant specificities can likewise be confirmed for the single coefficients of the estimated equations that determine the demand regime. For both groups of countries, the consumption dynamics depends more on the wage bill than on the operating surplus, in all cases with higher coefficients for the EC group of countries[37]. With reference to the investment dynamics, the predomination of a strict relationship between this variable and the operating surplus for the NON-EC group would seem to be significant, while for the EC group the investments appear to depend more on the value added dynamics[38] (confirming the Keynesian accelerator hypothesis). A different regime in the determination of the investment growth rate would therefore seem to prevail in the two areas: a regime with more classical characteristics for the United States, Canada and Japan, and a regime with more Keynesian characteristics for the EC countries[39]. With reference to the sharing of the benefits of technical progress over real incomes, it can be noted that if on the one hand real wages depend strongly on productivity for both the groups[40] (with a higher coefficient for the EC countries), the operating surplus is more affected by the productivity dynamics in the NON-EC countries than in the EC. In the latter, on the other hand, it is the dynamics of the value added that principally explains the variations of operating surplus; whereas this variable explains little in the NON-EC countries[41].

The estimates obtained with reference to the demand regime would therefore seem to indicate that for both the groups, if productivity increases so do wages, and if this favours the growth of the wage bill (because of the effects of productivity on employment given value added) consumption increases and hence the value added, which in its turn sustains the growth of investments. For the EC group investments are also stimulated by the growth of profits brought about by productivity increases, but they are more stimulated by the growth of value added (Keynesian regime). For the NON-EC group investments are on the other hand more stimulated by profit increases, which are significantly affected by

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37 As the partial coefficients of determination suggest, the explanatory power of the wage bill in the private consumption equation is higher for both NON-EC and EC countries (0.71 and 0.64 respectively) with respect to the operating surplus variable (0.44 and 0.20).

38 This is confirmed also by the partial coefficients of determination.

39 In addition, with respect to the different components of aggregate demand, the value added variable is more sensitive to changes in exports and government consumption for the EC countries than for the NON-EC countries, while it is more sensitive to changes in private consumption and investment for the NON-EC countries than for the EC countries.

40 In addition to the unemployment rate, the influence of which is similar in the two groups.

41 In the operating surplus equation the partial coefficients of determination referring to ILPG and VAIG are respectively 0.40 and 0.13 for the NON-EC group and 0.16 and 0.27 for the EC group.

the growth in productivity (the classical regime). A demand regime therefore would seem to emerge that stresses for both groups of countries the importance of the distribution of the productivity gains both to salaries and to profits, with more Keynesian features for the EC countries and more classical features for the NON-EC countries.

Moving on to the relative instability of the model over periods of time, the less favourable interrelations between demand growth and productivity growth in the second period (1976-1990) when compared to those of the first (1960-1976) would appear to be significant. The elasticity of the demand regime is significantly lower in the second than the first, going from 0.71 to 0.51, but the elasticity of the productivity regime is lower still, going from 0.97 to 0.36[42] (Chart 2).

In particular, concerning the productivity regime, the negative effects of the investment ratio on employment in the second period are greater than in the first (the employment equation). To this must be added the greater effects of value added on the investment ratio in the second period (the investment ratio equation), partly compensated for by the lesser effects of expenditure in R&D. Overall, the negative direct effects on employment brought about by the dynamics of the investment ratio are therefore greater from 1976-1990 than for 1960-1976. These effects are compensated for partly by the relatively greater sensitivity of employment to value added in the second period (the employment equation).

With reference to the role of the input and output variables of innovation activity, it would appear that from 1976-1990, as compared to 1960-1976, the positive effects of the input variable (R&DGP) on productivity (through the investment ratio) and the positive effects of the output variable (the patent auto-sufficiency ratio) on value added through exports are absent or considerably lower (in any case not significant)[43]. For the second period the double weakness of the driving role of the input and output variables of innovation activity - already shown by the estimates of the external causation model - which contributes to the simultaneous reduction of the coefficients of the productivity and demand regimes, determining in this way a lower growth ratio in these variables, would seem to find confirmation.

When we consider the demand regime, significant changes emerge in the role played by the variables which influence the dynamics of investments, of real wages, and of operating surplus. Comparing the first and the second period a greater sensitivity of investments with respect to operating surplus would seem to emerge, while that regarding

42 A similar result was obtained for the cumulative growth model with external causation (Pini, 1993, §.5).

43 As is suggested by the partial coefficients of determination, the explanatory power of the input and output variables of the innovation process is very low in the second period, while it is significant in the first one.

value added would seem to diminish[44]. This could be interpreted as the passage from a Keynesian to a classical regime in the determination of the demand component. As far as the influence of productivity on the dynamics of incomes is concerned, there are two particular issues: a) the positive link between the dynamics of real wages and the productivity dynamics turns out to weaken significantly in the second period, while the rate of unemployment, not particularly important in the first period, affects wages considerably in the second period[45]; b) in the second period the strongly positive link between the operating surplus dynamics and productivity would seem to be strengthened, while the explanatory capacity of value added in the determination of the operating surplus disappears[46]. There would therefore seem to be some evidence that while in the first period productivity had a positive influence on wages rather than on profits, in the second period the opposite happened.

We are therefore led to conclude that in the determination both of investments and of real wages from 1960-1976 and 1976-1990 a substantial change in the characteristics of the demand regime took place, i.e. the passage from a Keynesian-type regime to one of a classical type. Specifically, there would seem to be evidence of a first period characterised by a more Keynesian regime, while in the second a more classical regime emerges, both in the demand dynamics (particularly investments) and in the distribution of income and the sharing out of productivity gains to profits and wages. The change of the growth regime in demand and distribution could be an important explanatory factor in the lowering of both the coefficients of the demand and productivity regimes. The lower sharing out of the productivity gains to wages, together with the growth of the rate of unemployment, seems to have penalised the demand for consumer goods and lowered the growth of value added. At the same time, greater profits (due to the sharing of productivity gains) have stimulated investments to a greater extent and have therefore partly compensated for the previous effect on internal demand. In any case, with respect to the first period the growth of the foreign component of demand has also turned out to be less of a stimulus to value added, while a greater stimulus was found in government consumption. The overall effects on the demand regime seem however to indicate a penalisation of the link between productivity growth and the growth of demand, insofar as

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44 With respect to the investment equation, while in the 1960-1976 period the VAIG variable has a high explanatory power (a partial coefficient of determination 0.58) in the period 1976-1990 its role seems much less important (a partial coefficient of determination 0.12). Vice versa, OSG presents a high explanatory power in the second period and its role is weak in the first period (the partial coefficient of determination changes from 0.11 to 0.35 in the two periods).

45 In the real compensation equation the explanatory power of the ILPG variable decreased substantially from the first to the second period (the partial coefficient of determination decreases from 0.44 to 0.15), while the explanatory power of UR significantly increased (from 0.001 to 0.43).

46 In the operating surplus equation the explanatory power of the ILPG variable slightly increased from the first to the second period (the partial coefficient of determination changes from 0.38 to 0.48), while that of VAIG substantially decreased (from 0.71 to 0.008).

the negative effects on wages and therefore on consumption brought about by the altered regime do not appear to be compensated for by the dynamics of profits, of investments and of the other components of demand (exports and government consumption).

## 5. *Some critical observations on the integrated model.*

The analysis carried out has allowed us to show how in the determination of the effects of technological change on the volume of employment it is essential to consider together the changes that occur in the dynamics of both supply and demand.

The dynamics of employment, in fact, is the result of the interaction between the productivity dynamics and its effects on the supply side and of the demand dynamics and its specific components, the result of those same productivity increases. It can be seen from this that high rates of growth of labour productivity do not necessarily imply less employment growth, and this is confirmed by the experience of all in the countries under consideration from the start of the sixties to the crisis phase half-way through the seventies. At the same time, even reduced productivity growth rates where accompanied by similarly reduced demand growth rates can be associated with low or even negative employment growth rates, and there is evidence for this in the same countries in the period following the mid-seventies. At the same time the analysis has shown that the interaction between productivity and demand has specific relevance also for groups of countries, as well as for periods, demonstrating the way that in EC countries such interaction has turned out to be less favourable to employment compared to the NON-EC countries examined.

The integrated model utilised in this paper would appear capable of supplying more adequate explanations to such dynamics if compared to the simpler external causation model, locating in the determination of the demand regime important factors such as the dynamics of incomes following productivity increases and the sensitivity of the distinct private components of demand to these dynamics, which occur in the process of economic growth in the presence of technological change.

However, it is also necessary to reflect on the theoretical limitations of the model when subjected to empirical analysis. The model can in fact be criticised theoretically, in terms of the analysis of the effects of technological change on the dynamics of the growth of demand, productivity and employment, and empirically in terms of the specification of certain behaviour relations.

The integrated cumulative growth model, in fact, shares certain limitations common to all the cumulative growth models of the regulation school. Four limitations in particular seem to be especially important, and future research could develop along the lines indicated here to overcome them.

First, the specification of the influence of technological change is based on the notion of technological change as a process of accumulation and therefore on the labour saving features of process innovations and thus also on productivity increases. These have negative direct effects on employment through the investment ratio and positive compensatory effects on income and price. They operate in the first case through the sharing of the benefits of technical progress (greater productivity) over the real incomes of the various social categories (profit earners and wage earners), and in the second case through greater competitiveness of national products on foreign markets, deriving from increases in productivity. A further compensation effect must also be taken into consideration, that of the multiplier role of technology in the production of capital goods. With the partial exception of the role played by the indicators of the output of the innovation process in the exports equation which could capture a qualitative effect of technical progress on such a demand component, the features of technological change concerning product innovation are neglected. Hence an important component that occurs in the medium- and long-term in the determination of demand growth is not taken into consideration. This limitation does not derive only from the difficulty in capturing the qualitative effects through specific variables of output of the innovation activity relating to the product innovations[47], as from the overall specification of the model, this being centred on the effects of technical progress mediated through productivity on demand, incomes and their distribution.

Second, the model stresses the role of investment in physical capital and neglects that of capital formation in intangible activities. This latter component has in fact become central in the growth process of dynamic economic systems. In reality these are increasingly characterised by a high intensity of skills, information and knowledge, which must be seen as strategic resources for which the learning process in the adoption, diffusion and utilisation of new technologies determines the actual dynamics of the productivity of the system[48]. This aspect allows us also to stress all the more the role of non-price factors in the determination of competitiveness of goods and services offered by an economic system on international markets. More importance should be given to the value of human capital and of those productive sectors which have a higher intensity of knowledge or skills[49].

Third, precisely in the specification of the role played by the input and output variables, their total exogeneity is assumed with respect to the economic variables, while what turns out to be endogenous is the influence exercised by the demand dynamics on

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[47] This would seem to be the case for example of the specification of the consumption equation, in which in the absence of suitable indicators the task of representing product innovations is left to the constant.

[48] This would seem to be particularly important given the increasing role in the eighties assumed by information technologies in the process of economic growth. For a simulation analysis of the impact of information technologies on the economic system see Golinelli - Pini (1992).

[49] See the structural analyses carried out by OECD that employ specific distinctions between industrial sectors based on technological, orientation and wage criteria (OECD, 1992).

the investment ratio and hence on the dynamics of employment and of productivity, that is, the Kaldor-Verdoorn returns to scale. The model should instead account for decisions over expenditure in R&D and how these are subsequently translated into results of product and process innovation activity[50].

Finally, in terms of the specification of the model, in the connections suggested by the French regulation school concerning the sharing of productivity increases over incomes and their distribution, the mechanisms of the determination of the price of the product and how this is influenced by technological change are not explained. For this reason in the exports equation the productivity variable rather than the price variable intervenes directly to determine the pattern of this demand component. In this way the price effects are only implicitly considered and the problem remains what happens if, in the presence of non-competitive market forms, productivity increases are not translated into price reductions but into growth in nominal incomes (and real incomes). On the other hand, this is what is assumed with reference to the specification of the income compensation effects in the equations of the determination of real wages and real profits, with the influence exercised by the dynamics of labour productivity on such distributive variables. And it is in this context that the lack of a specific treatment of the determination of the level of prices of industrial products appears to be particularly important, leading us to place a direct relationship of the real wages per employee and the operating surplus with labour productivity[51].

## 6. *Abbreviations*

| | |
|---|---|
| EIG | Rate of growth of industrial employment |
| ISY | Share of fixed investment out of gross national product (investment ratio), at constant prices |
| VAIG | Rate of growth of value added in industry, at constant prices |
| EXPG | Rate of growth of industry exports, at constant prices |
| ILPG | Rate of growth of labour productivity in industry |
| IDG | Rate of growth of domestic demand, at constant prices |
| GCG | Government consumption growth, at constant prices |
| PCG | Private consumption growth, at constant prices |

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50 Some interesting indications on this subject have been recently published in Amable - Boyer (1992).

51 Such limitations have already been shown by Pugno (1987), a work in which serious doubts about the theoretical solidity of the model were advanced. Among other things, justifiable doubts were raised about the link between investments and profitability which should be more correctly expressed "in its meaning of expectation" (Pugno, 1987, p.90) so that it would not be confused with demand, the profits gained being a component of the determination of demand. In the same way we could add that demand even in the same equation should be expressed in its meaning of expectation until a similar issue does not emerge for this component too.

With reference to the somewhat inadequate treatment of technological change in the French regulation school model, a series of strong criticisms has been expressed in a recent study by Fucher - De Bresson (1991) to which Amable - Lordon (1992) have supplied some partly satisfying answers, but which have left some problems open among which those we have shown earlier.

| | |
|---|---|
| PFIG | Private gross fixed investment growth, industry, at constant prices |
| OSG | Operating surplus growth, industry, at constant prices |
| RWG | Growth of compensations for employee, industry, at constant prices |
| WBG | Growth of wage bill, industry, at constant prices |
| UR | Unemployment rate |
| MEG | Rate of growth of machinery and equipment investment, at constant prices |
| MESI | Share of machinery and equipment out of total fixed investment, at constant prices |
| MESIG | Rate of growth of the machinery and equipment share out of total fixed investment, at constant prices |
| ISYJ | Dummy variable for Japan in the investment equation |
| EEXRG | Variation rate of effective exchange rate |
| R&DGP | Rate of growth of total research and development expenditure (previous cycle), at constant prices |
| PAT-ASR | Patent auto-sufficiency ratio (domestic/national applications) |
| PAT-CMPR | Patent competitive ratio (external/foreign applications) |
| BTCR | Coverage ratio (receipts/payments) of technological balance of payments, at current price |
| HTGEIR | Ratio between the value of export share of high-technology products out of total export and the value of import share of high-technology products out of total import, at current prices |
| NPATG | Variation rate of national patent applications (patent applications in a specific country by the residents and non residents) |
| NPATRPOPG | Variation rate of the ratio between national patent applications and population |
| N | Number of observations |
| RSQ | Coefficient of determination |
| ARSQ | Adjusted coefficient of determination |
| SER | Standard error of the regression |
| SSR | Sum of square of the residuals |
| 2SLS | Two stage least squares, TSP 4.2b |
| 3SLS | Three stage least squares, TSP 4.2b |
| HWTY | White test for heteroskedasticity using fitted values of dependent variable y and $y^2$ |
| HBPT | Breusch and Pagan test for heteroskedasticity using regressors $x_i$, $x_j$, $x_i^2$, $x_j^2$ and $x_i \cdot x_j$ |
| F TEST | F distribution test |
| W TEST | Wald test |
| LM TEST | Lagrange multiplier test |
| LR TEST | Likelihood ratio test |
| HT | Hausman exogeneity test |
| SBT | Spencer - Berk exogeneity test |
| DF | Degree of freedom |

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Tab. 1a: Employment, value added and productivity for nine OECD countries

Correlation coefficients

Cycle database: employment, value added and productivity

| | EIG-VAIG | EIG-ILPG | VAIG-ILPG |
|---|---|---|---|
| 1960-1990 | 0,65 | 0,03 | 0,74 |
| 1960-1976 | 0,67 | 0,19 | 0,85 |
| 1976-1990 | 0,57 | -0,51 | 0,43 |

| | EIG-VAIG | EIG-ILPG | VAIG-ILPG |
|---|---|---|---|
| NON-E.C. | 0,61 | 0,13 | 0,86 |
| E.C. | 0,65 | 0,02 | 0,77 |

Annual database: employment and productivity

| | EIG-ILPG | | |
|---|---|---|---|
| | 1960-1990 | 1960-1976 | 1976-1990 |
| USA | 0,28 | 0,38 | 0,17 |
| CAN | -0,01 | 0,18 | -0,22 |
| JPN | 0,56 | 0,55 | -0,21 |
| B | 0,08 | 0,32 | -0,23 |
| F | 0,35 | 0,31 | -0,12 |
| D | 0,34 | 0,54 | -0,16 |
| I | -0,11 | -0,15 | -0,31 |
| NL | -0,07 | -0,03 | -0,45 |
| UK | -0,26 | 0,11 | -0,48 |

Tab. 1b: Employment, value added and productivity for nine OECD countries

| | Avarage annual rate of change in the cycles (%) | | | Employment and productivity elasticity to output | |
|---|---|---|---|---|---|
| | VAIG | EIG | ILPG | EE = EIG/VAIG | PE = ILPG/VAIG |
| 1960-1990 | 3,32 | -0,18 | 3,50 | -0,05 | 1,05 |
| NON-E.C. | 4,42 | 1,33 | 3,08 | 0,30 | 0,70 |
| E.C. | 2,75 | -0,98 | 3,72 | -0,36 | 1,36 |
| 1960-1976 | 4,42 | 0,37 | 4,05 | 0,08 | 0,92 |
| 1976-1990 | 2,19 | -0,64 | 2,83 | -0,29 | 1,29 |
| Countries | | | | | |
| USA | 3,38 | 1,1 | 2,28 | 0,33 | 0,67 |
| CAN | 3,61 | 1,68 | 1,93 | 0,47 | 0,53 |
| JPN | 6,69 | 1,14 | 5,55 | 0,17 | 0,83 |
| B | 3,44 | -1,45 | 4,89 | -0,42 | 1,42 |
| F | 2,33 | -0,79 | 3,12 | -0,34 | 1,34 |
| D | 2,37 | -0,72 | 3,09 | -0,30 | 1,30 |
| I | 4,08 | -0,23 | 4,31 | -0,06 | 1,06 |
| NL | 3,04 | -0,92 | 3,96 | -0,30 | 1,30 |
| UK | 1,2 | -1,69 | 2,89 | -1,41 | 2,41 |

| | | Avarage annual rate of change in the cycles (%) | | | Employment and productivity elasticity to output | |
|---|---|---|---|---|---|---|
| Countries | | VAIG | EIG | ILPG | EE = EIG/VAIG | PE = ILPG/VAIG |
| USA | '60-'76 | 3,79 | 1,25 | 2,54 | 0,33 | 0,67 |
| | '76-'90 | 2,93 | 0,9 | 1,93 | 0,32 | 0,68 |
| CAN | '60-'76 | 5,03 | 2,45 | 2,58 | 0,49 | 0,51 |
| | '76-'90 | 2,2 | 0,9 | 1,3 | 0,41 | 0,59 |
| JPN | '60-'76 | 7,96 | 1,71 | 6,25 | 0,21 | 0,79 |
| | '76-'90 | 5,42 | 0,57 | 4,85 | 0,11 | 0,89 |
| B | '60-'76 | 4,91 | -0,38 | 5,27 | -0,07 | 1,07 |
| | '76-'90 | 1,47 | -2,91 | 4,38 | -1,98 | 2,98 |
| F | '60-'76 | 3,9 | 0,48 | 3,42 | 0,12 | 0,88 |
| | '76-'90 | 1,15 | -1,75 | 2,9 | -1,52 | 2,52 |
| D | '60-'76 | 3,21 | -1,18 | 4,39 | -0,37 | 1,37 |
| | '76-'90 | 1,54 | -0,26 | 1,8 | -0,17 | 1,17 |
| I | '60-'76 | 4,9 | 0,15 | 4,75 | 0,03 | 0,97 |
| | '76-'90 | 2,99 | -0,76 | 3,75 | -0,25 | 1,25 |
| NL | '60-'76 | 5,35 | -1,15 | 6,5 | -0,21 | 1,21 |
| | '76-'90 | 0,73 | -0,33 | 1,06 | -0,45 | 1,45 |
| UK | '60-'76 | 0,39 | -1,44 | 1,83 | -3,69 | 4,69 |
| | '76-'90 | 1,81 | -1,88 | 3,69 | -1,04 | 2,04 |

Fig. 2: Value added and productivity

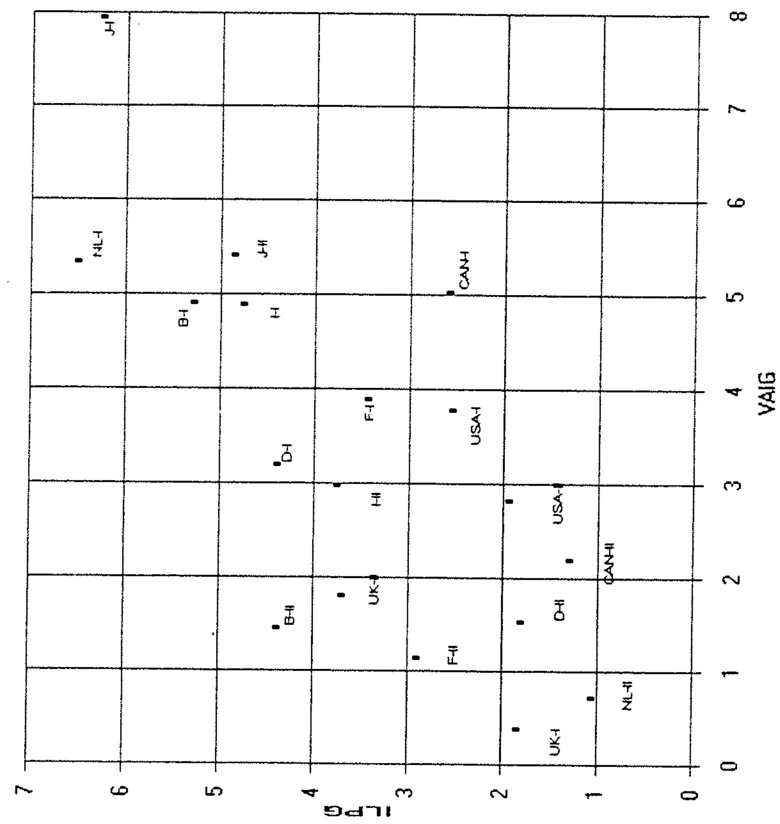
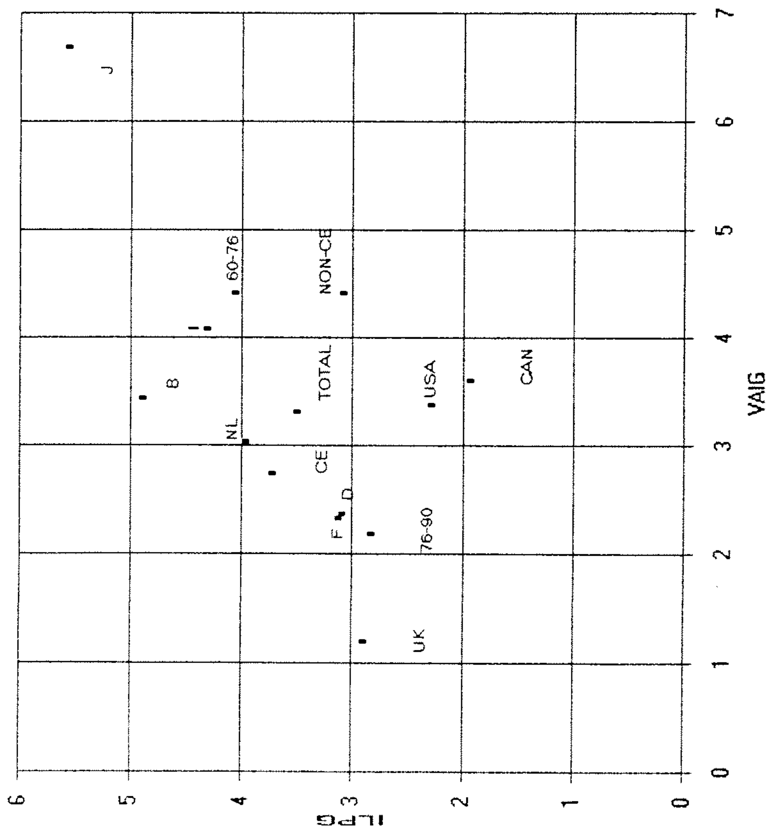



Fig. 1: Value added and productivity



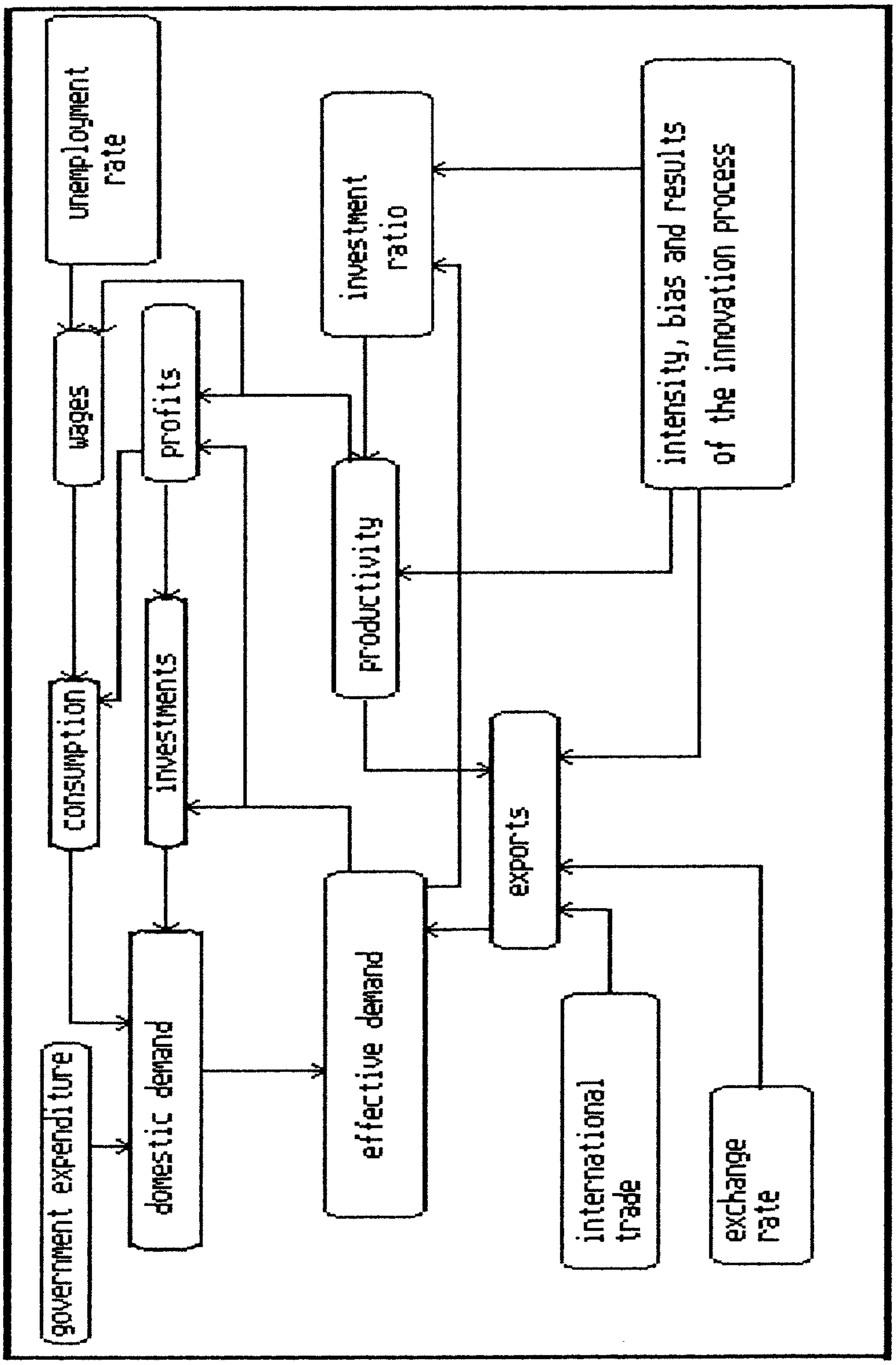



Fig.3: An integrated model of cumulative growth

Tab. R1-I: Estimate of the cumulative growth model 1-I

STRUCTURAL FORM @

| Variables \ Equations | EIG | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG |
|---|---|---|---|---|---|---|---|---|
| C | 0.02* | 19.35 | -2.6 | 0.002* | 1.891 | 0.236* | 2.105 | 0.04* |
| VAIG | 0.576 | 0.313 | | | | 0.767 | | 0.204 |
| PCG | | | 0.806 | | | | | |
| PFIG | | | 0.26 | | | | | |
| EXPG | | | 0.183 | | | | | |
| GCG | | | 0.22 | | | | | |
| ISY | -0.1 | | | | | | | |
| ISYJ | | 8.654 | | | | | | |
| ILPG | | | | 1.674 | | | 0.67 | 0.64 |
| MEG | 0.039* | | | 0.04 | | | | |
| EEXRG | | | | -0.27 | | | | |
| R&DGP | | 0.153 | | | | | | |
| PAT-ASR | | | | 2.53 | | | | |
| WBG | | | | | 0.423 | | | |
| ROSG | | | | | 0.198 | 0.563 | | |
| UR | | | | | | | -0.25 | |
| N 61 | | | | | | | | |
| RSQ | 0.435 | 0.65 | 0.739 | 0.821 | 0.783 | 0.64 | 0.571 | 0.55 |
| ARSQ | 0.406 | 0.631 | 0.72 | 0.809 | 0.772 | 0.628 | 0.549 | 0.535 |
| SER | 1.492 | 2.437 | 1.396 | 3.268 | 0.866 | 3.318 | 1.527 | 2.991 |
| SSR | 129.1 | 344.6 | 111.1 | 608.6 | 44.2 | 649.5 | 137.5 | 527.8 |
| HWTY | 0.025 | 0.073 | 0.008 | 0.949 | 0.529 | 0.977 | 0.007 | 0.836 |
| HBPT | 1.443 | 0.057 | 13.41 | 0.179 | 0.774 | 0.008 | 0.115 | 0.018 |

Partial coefficients of determination

| Variables \ Equations | EIG | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG |
|---|---|---|---|---|---|---|---|---|
| VAIG | 0.49 | 0.17 | | | | 0.302 | | 0.084 |
| PCG | | | 0.072 | | | | | |
| PFIG | | | 0.317 | | | | | |
| EXPG | | | 0.313 | | | | | |
| GCG | | | 0.056 | | | | | |
| ISY | 0.513 | | | | | | | |
| ISYJ | | 0.686 | | | | | | |
| ILPG | | | | 0.648 | | | 0.255 | 0.138 |
| MEG | 0.017 | | | 0.054 | | | | |
| EEXRG | | | | 0.243 | | | | |
| R&DGP | | 0.12 | | | | | | |
| PAT-ASR | | | | 0.102 | | | | |
| WBG | | | | | 0.64 | | | |
| OSG | | | | | 0.145 | 0.106 | | |
| UR | | | | | | | 0.442 | |

REDUCED FORM

| Exogenous variables | EIG | VAIG | ILPG |
|---|---|---|---|
| C | 0.224* | -0.401* | -0.176* |
| EEXRG | -0.12 | -0.221 | -0.101 |
| MEG | 0.017* | -0.041* | -0.058* |
| PAT-ASR | 1.146 | 2.101 | 0.956 |
| UR | -0.21 | -0.385 | -0.175 |
| GCG | 0.545 | 1.001 | 0.455 |
| ISYJ | -0.03* | 1.503 | 1.533 |
| R&DGP | -0.001* | 0.026 | 0.027 |

Demand and productivity regimes §

| | demand | productivity |
|---|---|---|
| dq/dpr | 0.981 | |
| dpr/dq | | 0.455 |

| | dq/dxj | dpr/dxi |
|---|---|---|
| C | -0.252* | 0.031 |
| EEXRG | -0.12 | |
| MEG | 0.017* | -0.039* |
| PAT-ASR | 1.164 | |
| UR | -0.21 | |
| GCG | 0.554 | |
| ISYJ | | 0.849 |
| R&DGP | | 0.015 |

@ Estimation method 3SLS.

* Not significant at the 95% level of confidance.

§ Stability condition satisfied if (dpr/dq)<1/(dq/dpr).

Tab. R1C: Estimate of the cumulative growth model 1-I

STRUCTURAL FORM @

| Variables \ Equations | NON-E.C. COUNTRIES | | | | | | | | E.C. COUNTRIES | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EIG | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG | EIG | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG |
| C | 0.01* | 18.9 | -4.7 | 0.03* | 2.26 | 0.27* | 1.66 | 0.21* | 0.12* | 18.7 | -1.7 | 0.01* | 1.63 | 0.22* | 0.61* | 0.05* |
| VAIG | 0.2 | 0.07 | | | | 0.49 | | 0.1 | 0.46 | 0.71 | | | | 0.84 | | 0.54 |
| PCG | | | 0.86 | | | | | | | | 0.65 | | | | | |
| PFIG | | | 0.38 | | | | | | | | 0.11 | | | | | |
| EXPG | | | 0.06 | | | | | | | | 0.25 | | | | | |
| GCG | | | 0.12 | | | | | | | | 0.41 | | | | | |
| ISY | -0.04 | | | | | | | | -0.1 | | | | | | | |
| ISYJ | | 10.6 | | | | | | | | | | | | | | |
| ILPG | | | | 1.26 | | | 0.66 | 0.71 | | | | 1.47 | | | 1.04 | 0.12 |
| MEG | 0.16 | | | 0.06 | | | | | 0.04* | | | 0.08 | | | | |
| EEXRG | | | | -0.54 | | | | | | | | -0.02* | | | | |
| R&DGP | | 0.19 | | | | | | | | 0.1 | | | | | | |
| PAT-ASR | | | | 7.08 | | | | | | | | 1.73 | | | | |
| WBG | | | | | 0.39 | | | | | | | | 0.48 | | | |
| OSG | | | | | 0.15 | 1.04 | | | | | | | 0.25 | 0.32 | | |
| UR | | | | | | | -0.23 | | | | | | | | -0.21 | |
| N | 21 | | | | | | | | 40 | | | | | | | |
| RSQ | 0.81 | 0.83 | 0.73 | 0.9 | 0.86 | 0.7 | 0.54 | 0.72 | 0.57 | 0.33 | 0.75 | 0.86 | 0.73 | 0.55 | 0.61 | 0.43 |
| ARSQ | 0.78 | 0.8 | 0.66 | 0.87 | 0.84 | 0.69 | 0.48 | 0.69 | 0.54 | 0.28 | 0.72 | 0.85 | 0.71 | 0.53 | 0.57 | 0.31 |
| SER | 1.01 | 2.51 | 1.77 | 3.05 | 0.8 | 4.12 | 2.02 | 2.9 | 1.24 | 2.4 | 1.26 | 2.659 | 0.91 | 2.93 | 1.25 | 3 |
| SSR | 18.2 | 114 | 53.24 | 159 | 12.2 | 322 | 77.5 | 160 | 57 | 213 | 56.8 | 254.6 | 31.4 | 326 | 59.3 | 342 |
| HWTY | 2.81 | 0.21 | 0.54 | 1.11 | 6.8^ | 0.08 | 0.1 | 2.42 | 1.92 | 0.06 | 1.1 | 0.05 | 0.17 | 0.32 | 6.1^ | 0.36 |
| HBPT | 7.6 | 0.53 | 12.21 | 1.12 | 10.1 | 0.01 | 0.12 | 0.19 | 5.61 | 0.01 | 5.26 | 0.33 | 0.59 | 0.01 | 1.48 | 0.03 |

REGIMES

| | | non-e.c. | e.c. |
|---|---|---|---|
| Productivity regime | dpr/dq | 0.8 | 0.62 |
| Demand regime | dq/dpr | 0.76 | 0.87 |

Partial coefficients of determination

| Variables \ Equations | EIG | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG | EIG | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VAIG | 0.14 | 0.13 | | | | 0.12 | | 0.13 | 0.39 | 0.31 | | | | 0.39 | | 0.27 |
| PCG | | | 0.41 | | | | | | | | 0.42 | | | | | |
| PFIG | | | 0.25 | | | | | | | | 0.14 | | | | | |
| EXPG | | | 0.12 | | | | | | | | 0.12 | | | | | |
| GCG | | | 0.04 | | | | | | | | 0.14 | | | | | |
| ISY | 0.13 | | | | | | | | 0.57 | | | | | | | |
| ISYJ | | 0.92 | | | | | | | | | | | | | | |
| ILPG | | | | 0.52 | | | 0.53 | 0.4 | | | | 0.821 | | | 0.39 | 0.16 |
| MEG | 0.51 | | | 0.14 | | | | | 0.03 | | | 0.12 | | | | |
| EEXRG | | | | 0.79 | | | | | | | | 0.005 | | | | |
| R&DGP | | 0.22 | | | | | | | | 0.13 | | | | | | |
| PAT-ASR | | | | 0.53 | | | | | | | | 0.15 | | | | |
| WBG | | | | | 0.71 | | | | | | | | 0.64 | | | |
| OSG | | | | | 0.44 | 0.17 | | | | | | | 0.2 | 0.17 | | |
| UR | | | | | | | 0.26 | | | | | | | | 0.33 | |

@ Estimation method 3SLS.

§ Stability condition satisfied if (dpr/dq)<1/(dq/dpr).

* Not significant at the 95% level of confidance.

^ Significant at the 95% level of confidance.

Tab. R1P: Estimate of the cumulative growth model 1-I

STRUCTURAL FORM @

| Variables \ Equations | EIG 1960-1976 | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG | EIG 1976-1990 | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 0.31* | 19.5 | -0.7 | 0.8* | 2.73 | 0.29* | 0.67 | 0.21* | 0.19* | 19.02 | -4.1 | 0.6* | 2.21 | 0.8* | 2.05 | 0.1* |
| VAIG | 0.31 | 0.21 | | | | 0.65 | | 1.03 | 0.56 | 0.51 | | | | 0.25 | | 0.14* |
| PCG | | | 0.88 | | | | | | | | 0.75 | | | | | |
| PFIG | | | 0.21 | | | | | | | | 0.25 | | | | | |
| EXPG | | | 0.16 | | | | | | | | 0.07 | | | | | |
| GCG | | | 0.2 | | | | | | | | 0.18 | | | | | |
| ISY | -0.1 | | | | | | | | -0.2 | | | | | | | |
| ISYJ | | 7.93 | | | | | | | | 7.46 | | | | | | |
| ILPG | | | | 1.63 | | | 0.93 | 0.51 | | | | 1.01 | | | 0.4 | 0.84 |
| MEG | 0.14 | | | -0.02* | | | | | 0.23 | | | 0.31 | | | | |
| EEXRG | | | | -0.31 | | | | | | | | -0.3 | | | | |
| R&DGP | | 0.24 | | | | | | | | -0.001* | | | | | | |
| PAT-ASR | | | | 4.61 | | | | | | | | 1.18* | | | | |
| WBG | | | | | 0.42 | | | | | | | | 0.44 | | | |
| OSG | | | | | 0.14 | 0.11 | | | | | | | 0.1 | 0.96 | | |
| UR | | | | | | | 0.04* | | | | | | | | -0.2 | |
| N | 31 | | | | | | | | 30 | | | | | | | |
| RSQ | 0.62 | 0.7 | 0.78 | 0.92 | 0.84 | 0.69 | 0.598 | 0.74 | 0.58 | 0.63 | 0.72 | 0.79 | 0.69 | 0.65 | 0.59 | 0.65 |
| ARSQ | 0.58 | 0.67 | 0.74 | 0.9 | 0.73 | 0.67 | 0.569 | 0.72 | 0.53 | 0.58 | 0.67 | 0.76 | 0.66 | 0.62 | 0.15 | 0.63 |
| SER | 1.21 | 2.56 | 1.29 | 2.7 | 0.88 | 3.19 | 1.69 | 2.21 | 1.36 | 2.253 | 1.56 | 2.76 | 0.82 | 3.27 | 1.31 | 2.806 |
| SSR | 41.3 | 183 | 45.2 | 196.8 | 22.5 | 296 | 82.87 | 141 | 50.2 | 137.1 | 63.2 | 198 | 19 | 299 | 47.9 | 220.5 |
| HWTY | 0.23 | 0.08 | 0.56 | 0.02 | 1.09 | 1.22 | 0.001 | 2.08 | 0.3 | 1.4 | 3.4 | 0.65 | 0.2 | 0.01 | 0.88 | 0.29 |
| HBPT | 3.89 | 0.02 | 22.6 | 0.8 | 5.07 | 0.06 | 0.76 | 0.35 | 4.42 | 0.15 | 25.0^ | 0.66 | 0.42 | 0.01 | 3.92 | 0.001 |

REGIMES

| | | 1960-1976 | 1976-1990 |
|---|---|---|---|
| Productivity regime | dpr/dq | 0.71 | 0.51 |
| Demand regime | dq/dpr | 0.91 | 0.36 |

Partial coefficients of determination

| Variables \ Equations | EIG 1960-1976 | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG | EIG 1976-1990 | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VAIG | 0.16 | 0.19 | | | | 0.58 | | 0.71 | 0.41 | 0.09 | | | | 0.12 | | 0.008 |
| PCG | | | 0.45 | | | | | | | | 0.32 | | | | | |
| PFIG | | | 0.74 | | | | | | | | 0.21 | | | | | |
| EXPG | | | 0.23 | | | | | | | | 0.11 | | | | | |
| GCG | | | 0.37 | | | | | | | | 0.31 | | | | | |
| ISY | 0.43 | | | | | | | | 0.72 | | | | | | | |
| ISYJ | | 0.71 | | | | | | | | 0.52 | | | | | | |
| ILPG | | | | 0.79 | | | 0.44 | 0.38 | | | | 0.47 | | | 0.15 | 0.48 |
| MEG | 0.13 | | | 0.001 | | | | | 0.59 | | | 0.59 | | | | |
| EEXRG | | | | 0.31 | | | | | | | | 0.32 | | | | |
| R&DGP | | 0.46 | | | | | | | | 0.001 | | | | | | |
| PAT-ASR | | | | 0.36 | | | | | | | | 0.02 | | | | |
| WBG | | | | | 0.71 | | | | | | | | 0.66 | | | |
| OSG | | | | | 0.44 | 0.11 | | | | | | | 0.13 | 0.35 | | |
| UR | | | | | | | 0.001 | | | | | | | | 0.43 | |

@ Estimation method 3SLS.

§ Stability condition satisfied if (dpr/dq)<1/(dq/dpr).

* Not significant at the 95% level of confidance.

^ Significant at the 95% level of confidance.

Tab. CP: Estimate parameters, for groups of countries and periods, model 1-I @

| Variables | Parameters | 1960-1990 | 1960-1976 | 1976-1990 | NON-E.C. | E.C. |
|---|---|---|---|---|---|---|
| ISY | e1 | -0.1 | -0.1 | -0.2 | -0.04 | -0.1 |
| VAIG | e2 | 0.58 | 0.31 | 0.56 | 0.2 | 0.46 |
| MEG | e3 | 0.039* | 0.14 | 0.23 | 0.16 | 0.04* |
| VAIG | i1 | 0.31 | 0.21 | 0.51 | 0.07 | 0.71 |
| ISYJ | i2 | 8.65 | 7.93 | 7.46 | 10.6 | - |
| R&DGP | i3 | 0.15 | 0.24 | -0.001* | 0.19 | 0.1 |
| EXPG | v1 | 0.18 | 0.16 | 0.07 | 0.06 | 0.25 |
| PCG | v2 | 0.81 | 0.88 | 0.75 | 0.86 | 0.65 |
| PFIG | v3 | 0.26 | 0.21 | 0.25 | 0.38 | 0.11 |
| GCG | v4 | 0.22 | 0.2 | 0.18 | 0.12 | 0.41 |
| ILPG | x1 | 1.67 | 1.63 | 1.01 | 1.26 | 1.47 |
| EEXRG | x2 | -0.27 | -0.31 | -0.3 | -0.54 | -0.02* |
| MEG | x3 | 0.04 | -0.02* | 0.31 | 0.06 | 0.08 |
| PAT-ASR | x4 | 2.53 | 4.61 | 1.18* | 7.08 | 1.73 |
| WBG | c1 | 0.42 | 0.42 | 0.44 | 0.39 | 0.48 |
| OSG | c2 | 0.19 | 0.14 | 0.1 | 0.15 | 0.25 |
| OSG | s1 | 0.56 | 0.11 | 0.96 | 1.04 | 0.32 |
| VAIG | s2 | 0.77 | 0.65 | 0.25 | 0.49 | 0.84 |
| ILPG | w1 | 0.67 | 0.93 | 0.4 | 0.66 | 1.04 |
| UR | w2 | -0.25 | 0.04* | -0.15 | -0.23 | -0.21 |
| ILPG | p1 | 0.64 | 0.51 | 0.84 | 0.71 | 0.12 |
| VAIG | p2 | 0.2 | 1.03 | 0.14* | 0.1 | 0.54 |

@ Estimation method 3SLS.
* Not significant at the 95% level of confidance.

Tab. R2-I: Estimate of the cumulative growth model 2-I

STRUCTURAL FORM @

| Variables \ Equations | EIG | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG |
|---|---|---|---|---|---|---|---|---|
| C | 0.03* | 19.25 | -2.45 | 0.012* | 1.943 | 0.234* | 1.87 | 0.03* |
| VAIG | 0.591 | 0.343 | | | | 0.781 | | 0.18 |
| PCG | | | 0.718 | | | | | |
| PFIG | | | 0.279 | | | | | |
| EXPG | | | 0.191 | | | | | |
| GCG | | | 0.231 | | | | | |
| ISY | -0.1 | | | | | | | |
| ISYJ | | 8.624 | | | | | | |
| ILPG | | | | 1.8 | | | 0.736 | 0.667 |
| MEG | 0.04* | | | 0.02 | | | | |
| EEXRG | | | | -0.28 | | | | |
| R&DGP | | 0.153 | | | | | | |
| PAT-CMPR | | | | 0.249 | | | | |
| WBG | | | | | 0.422 | | | |
| OSG | | | | | 0.181 | 0.562 | | |
| UR | | | | | | | -0.24 | |
| N 61 | | | | | | | | |
| RSQ | 0.426 | 0.648 | 0.735 | 0.8 | 0.786 | 0.637 | 0.562 | 0.547 |
| ARSQ | 0.397 | 0.63 | 0.716 | 0.786 | 0.776 | 0.625 | 0.54 | 0.531 |
| SER | 1.503 | 2.445 | 1.405 | 3.459 | 0.86 | 3.331 | 1.543 | 3.003 |
| SSR | 131 | 346.6 | 112.5 | 682 | 43.6 | 654.8 | 140.5 | 531.9 |
| HWTY | 0.06 | 0.033 | 0.007 | 0.504 | 0.555 | 0.895 | 0.036 | 0.741 |
| HBPT | 1.409 | 0.059 | 11.96 | 0.176 | 0.788 | 0.007 | 0.146 | 0.017 |

Partial coefficients of determination

| Variables \ Equations | EIG | ISY | VAIG | EXPG | PCG | PIG | CEG | OSG |
|---|---|---|---|---|---|---|---|---|
| VAIG | 0.498 | 0.183 | | | | 0.322 | | 0.098 |
| PCG | | | 0.07 | | | | | |
| PFIG | | | 0.418 | | | | | |
| EXPG | | | 0.194 | | | | | |
| GCG | | | 0.045 | | | | | |
| ISY | 0.528 | | | | | | | |
| ISYJ | | 0.677 | | | | | | |
| ILPG | | | | 0.656 | | | 0.3 | 0.142 |
| MEG | 0.017 | | | 0.051 | | | | |
| EEXRG | | | | 0.23 | | | | |
| R&DGP | | 0.115 | | | | | | |
| PAT-CMPR | | | | 0.084 | | | | |
| WBG | | | | | 0.639 | | | |
| OSG | | | | | 0.119 | 0.113 | | |
| UR | | | | | | | 0.428 | |

REDUCED FORM

| Exogenous variables | EIG | VAIG | ILPG |
|---|---|---|---|
| C | -0.475* | -0.846* | -0.371* |
| EEXRG | -0.13 | -0.235 | -0.104 |
| MEG | -0.074* | -0.058* | -0.066* |
| PAT-CMPR | 0.117 | 0.211 | 0.094 |
| UR | -0.18 | -0.326 | -0.145 |
| GCG | 0.566 | 1.02 | 0.454 |
| ISYJ | 0.107* | 1.745 | 1.638 |
| R&DGP | 0.002* | 0.031 | 0.029 |

Demand and productivity regimes §

| | demand | productivity |
|---|---|---|
| dq/dpr | 1.066 | |
| dpr/dq | | 0.443 |

| | dq/dxj | dpr/dxi |
|---|---|---|
| C | -0.484* | 0.034 |
| EEXRG | -0.12 | |
| MEG | 0.09* | -0.04* |
| PAT-CMPR | 0.111 | |
| UR | -0.17 | |
| GCG | 0.541 | |
| ISYJ | | 0.865 |
| R&DGP | | 0.015 |

@ Estimation method 3SLS.

* Not significant at the 95% level of confidance.

§ Stability condition satisfied if (dpr/dq)<1/(dq/dpr).

Tab. R3-I: Estimate of the cumulative growth model 3-I

STRUCTURAL FORM @

| Variables \ Equations | EIG | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG |
|---|---|---|---|---|---|---|---|---|
| C | 0.03* | 19.53 | -3.03 | 0.04* | 1.892 | 0.25* | 2.162 | 0.015* |
| VAIG | 0.596 | 0.214 | | | | 0.744 | | 0.246 |
| PCG | | | 0.997 | | | | | |
| PFIG | | | 0.211 | | | | | |
| EXPG | | | 0.193 | | | | | |
| GCG | | | 0.171 | | | | | |
| ISY | -0.1 | | | | | | | |
| ISYJ | | 8.843 | | | | | | |
| ILPG | | | | 1.91 | | | 0.636 | 0.594 |
| MEG | 0.027* | | | -0.004* | | | | |
| EEXRG | | | | -0.229 | | | | |
| R&DGP | | 0.175 | | | | | | |
| BTCR | | | | 0.168 | | | | |
| WBG | | | | | 0.414 | | | |
| OSG | | | | | 0.207 | 0.585 | | |
| UR | | | | | | | -0.239 | |
| N 61 | | | | | | | | |
| RSQ | 0.413 | 0.651 | 0.734 | 0.776 | 0.78 | 0.637 | 0.572 | 0.555 |
| ARSQ | 0.382 | 0.633 | 0.715 | 0.76 | 0.769 | 0.624 | 0.55 | 0.54 |
| SER | 1.521 | 2.429 | 1.41 | 3.657 | 0.868 | 3.334 | 1.521 | 2.973 |
| SSR | 134.1 | 342.3 | 113.4 | 762.3 | 44.5 | 656 | 136.5 | 521.6 |
| HWTY | 0.099 | 0.217 | 0.01 | 0.061 | 0.438 | 0.999 | 1E-06 | 0.966 |
| HBPT | 1.286 | 0.05 | 17.14 | 0.188 | 0.829 | 0.008 | 0.104 | 0.019 |

Partial coefficients of determination

| Variables \ Equations | EIG | ISY | VAIG | EXPG | PCG | PIG | CEG | OSG |
|---|---|---|---|---|---|---|---|---|
| VAIG | 0.526 | 0.135 | | | | 0.317 | | 0.084 |
| PCG | | | 0.092 | | | | | |
| PFIG | | | 0.393 | | | | | |
| EXPG | | | 0.135 | | | | | |
| GCG | | | 0.066 | | | | | |
| ISY | 0.522 | | | | | | | |
| ISYJ | | 0.696 | | | | | | |
| ILPG | | | | 0.605 | | | 0.237 | 0.118 |
| MEG | 0.008 | | | 1E-05 | | | | |
| EEXRG | | | | 0.212 | | | | |
| R&DGP | | 0.143 | | | | | | |
| BTCR | | | | 0.089 | | | | |
| WBG | | | | | 0.628 | | | |
| OSG | | | | | 0.176 | 0.12 | | |
| UR | | | | | | | 0.424 | |

REDUCED FORM

| Exogenous variables | EIG | VAIG | ILPG |
|---|---|---|---|
| C | 0.102* | -0.178* | -0.076* |
| EEXRG | -0.15 | -0.257 | -0.109 |
| MEG | -0.007* | -0.06* | -0.052* |
| BTCR | 0.108 | 0.188 | 0.08 |
| UR | -0.33 | -0.573 | -0.244 |
| GCG | 0.569 | 0.99 | 0.421 |
| ISYJ | 0.333* | 2.1 | 1.767 |
| R&DGP | 0.007* | 0.041 | 0.034 |

Demand and productivity regimes §

| | demand | productivity |
|---|---|---|
| dq/dpr | 1.189 | |
| dpr/dq | | 0.425 |

| | dq/dxj | dpr/dxi |
|---|---|---|
| C | -0.113* | 0.021* |
| EEXRG | -0.13 | |
| MEG | -0.002* | -0.027* |
| BTCR | 0.093 | |
| UR | -0.28 | |
| GCG | 0.489 | |
| ISYJ | | 0.873 |
| R&DGP | | 0.017 |

@ Estimation method 3SLS.

* Not significant at the 95% level of confidance.

§ Stability condition satisfied if (dpr/dq)<1/(dq/dpr).

Tab. R4-I: Estimate of the cumulative growth model 4-I

STRUCTURAL FORM @

| Variables \ Equations | EIG | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG |
|---|---|---|---|---|---|---|---|---|
| C | 0.04* | 19.52 | -2.89 | 0.045* | 1.934 | 0.2* | 2.131 | 0.032* |
| VAIG | 0.565 | 0.211 | | | | 0.753 | | 0.246 |
| PCG | | | 0.903 | | | | | |
| PFIG | | | 0.24 | | | | | |
| EXPG | | | 0.201 | | | | | |
| GCG | | | 0.189 | | | | | |
| ISY | -0.1 | | | | | | | |
| ISYJ | | 8.98 | | | | | | |
| ILPG | | | | 1.859 | | | 0.65 | 0.59 |
| MEG | 0.037* | | | 0.007* | | | | |
| EEXRG | | | | -0.23 | | | | |
| R&DGP | | 0.174 | | | | | | |
| HTGEIR | | | | 0.383 | | | | |
| WBG | | | | | 0.415 | | | |
| OSG | | | | | 0.192 | 0.574 | | |
| UR | | | | | | | -0.25 | |
| N 61 | | | | | | | | |
| RSQ | 0.438 | 0.651 | 0.736 | 0.782 | 0.784 | 0.639 | 0.572 | 0.556 |
| ARSQ | 0.409 | 0.633 | 0.717 | 0.766 | 0.773 | 0.627 | 0.55 | 0.541 |
| SER | 1.487 | 2.43 | 1.406 | 3.61 | 0.866 | 3.324 | 1.526 | 2.972 |
| SSR | 128.3 | 342.6 | 112.6 | 742.9 | 44.2 | 651.8 | 137.4 | 521.1 |
| HWTY | 0.012 | 0.193 | 0.008 | 0.077 | 0.482 | 1.005 | 0.001 | 1.007 |
| HBPT | 1.446 | 0.049 | 15.76 | 0.135 | 0.831 | 0.008 | 0.113 | 0.019 |

Partial coefficients of determination

| Variables \ Equations | EIG | ISY | VAIG | EXPG | PCG | PFIG | RWG | OSG |
|---|---|---|---|---|---|---|---|---|
| VAIG | 0.457 | 0.134 | | | | 0.319 | | 0.082 |
| PCG | | | 0.067 | | | | | |
| PFIG | | | 0.303 | | | | | |
| EXPG | | | 0.121 | | | | | |
| GCG | | | 0.075 | | | | | |
| ISY | 0.468 | | | | | | | |
| ISYJ | | 0.688 | | | | | | |
| ILPG | | | | 0.511 | | | 0.233 | 0.109 |
| MEG | 0.017 | | | 0.001 | | | | |
| EEXRG | | | | 0.204 | | | | |
| R&DGP | | 0.148 | | | | | | |
| HTGEIR | | | | 0.097 | | | | |
| WBG | | | | | 0.621 | | | |
| OSG | | | | | 0.138 | 0.113 | | |
| UR | | | | | | | 0.421 | |

REDUCED FORM

| Exogenous variables | EIG | VAIG | ILPG |
|---|---|---|---|
| C | 0.309* | -0.573* | -0.274* |
| EEXRG | -0.14 | -0.264 | -0.12 |
| MEG | -0.002* | -0.071* | -0.069* |
| HTGEIR | 0.241 | 0.443 | 0.202 |
| UR | -0.29 | -0.529 | -0.241 |
| GCG | 0.592 | 1.087 | 0.495 |
| ISYJ | 0.29* | 2.12 | 1.83 |
| R&DGP | 0.005* | 0.041 | 0.036 |

Demand and productivity regimes §

| | demand | productivity |
|---|---|---|
| dq/dpr | 1.157 | |
| dpr/dq | | 0.456 |
| | dq/dxj | dpr/dxi |
| C | -0.244* | 0.02* |
| EEXRG | -0.13 | |
| MEG | 0.004* | -0.037* |
| HTGEIR | 0.209 | |
| UR | -0.25 | |
| GCG | 0.514 | |
| ISYJ | | 0.865 |
| R&DGP | | 0.017 |

@ Estimation method 3SLS.

* Not significant at the 95% level of confidance.

§ Stability condition satisfied if (dpr/dq)<1/(dq/dpr).

Tab. ST: Stability test for the model 1-I @

| F TEST | DF | EQ.1 4/53 | EQ.2 4/53 | EQ.3 %/51 | EQ.4 5/51 | EQ.5 3/56 | EQ.6 3/56 | EQ.7 3/56 | EQ.8 3/56 |
|---|---|---|---|---|---|---|---|---|---|
| MODEL 1-I | | | | | | | | | |
| | M1-M21-40 | 9.61 ^ | 0.76 | 0.10 | 4.82 ^ | 0.26 | 0.04 | 0.09 | 0.96 |
| | M1-M31-30 | 6.44 ^ | 1.01 | 0.33 | 6.62 ^ | 1.17 | 1.71 * | 0.94 | 8.43 ^ |
| Criteria for accepting the restrictions | | F< | F< | F< | F< | F< | F< | F< | F< |
| AKAIKE | | 0.86 | 0.86 | 0.82 | 0.82 | 0.94 | 0.94 | 0.94 | 0.94 |
| THEIL | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| AMEMIYA | | 1.91 | 1.91 | 1.88 | 1.88 | 1.94 | 1.94 | 1.94 | 1.94 |
| MALLOW | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| HOCKING | | 2.07 | 2.07 | 2.10 | 2.10 | 2.77 | 2.77 | 2.77 | 2.77 |

@ Estimation method 3SLS
^ Significant at the 99% level of confidance.
* Significant at the 90% level of confidance.

Tab.ET: Chi2 test of exogeneity $

| | Equations | Variables | Hausman Test | Spencer - Berk Test |
|---|---|---|---|---|
| Model 1 | VAJG | IDG | 2.740 | 0.650 |
| Model 1-I | | | | |
| | EIG | MEG | 3.270 | 1.080 |
| | ISY | R&DGP | 0.060 | 3.850 |
| | VAIG | GCG | 0.846 | 0.024 |
| | EXPG | EEXRG | 1.480 | 2.310 |
| | EXPG | MEG | * | 0.840 |
| | EXPG | PAT-ASR | 0.040 | 0.980 |
| | RWG | UR | 0.090 | 0.360 |
| Model 2-I | EXPG | PAT-CMPR | 0.039 | 1.159 |
| Model 3-I | EXPG | BTCR | 0.005 | 0.001 |
| Model 4-I | EXPG | HTGEIR | 0.052 | 0.677 |

* Test not conclusive for var(x3')-var(x3")<0, where x3' is the 2SLS estimate and x3" is the 3SLS estimate.
$ Level of significance of the Chi2 test (DF=1): 99% (6.63), 95% (3.84), 90% (2.71), 75% (1.32), 50% (0.46).

Tab. DB: Average values of the variables used

| Variables | 1960-1990 | NON-E.C. | E.C. | 1960-1976 | 1976-1990 |
|---|---|---|---|---|---|
| EIG | -0.181 | 1.334 | -0.976 | 0.266 | -0.642 |
| VAIG | 3.32 | 4.416 | 2.746 | 4.418 | 2.186 |
| ILPG | 3.501 | 3.081 | 3.721 | 4.162 | 2.828 |
| ISY | 22.013 | 23.627 | 21.218 | 23.089 | 20.901 |
| EXPG | 6.641 | 7.699 | 6.138 | 8.261 | 4.967 |
| PCG | 3.694 | 4.29 | 3.381 | 4.478 | 2.884 |
| PFIG | 3.566 | 6.462 | 2.674 | 4.043 | 3.071 |
| GCG | 3.052 | 3.433 | 2.861 | 3.884 | 2.191 |
| OSG | 3.092 | 3.822 | 2.708 | 2.393 | 3.813 |
| WBG | 2.731 | 3.769 | 2.191 | 4.734 | 0.66 |
| RWG | 2.912 | 2.426 | 3.167 | 4.469 | 1.303 |
| MEG | 6.636 | 8.314 | 4.23 | 6.424 | 6.866 |
| MESI | 38.687 | 36.381 | 39.898 | 36.316 | 41.137 |
| MESIG | 2.071 | 2.861 | 1.666 | 1.381 | 2.784 |
| ISYJ | 0.0984 | 0.286 | 0 | 0.0968 | 0.1 |
| EEXRG | -0.132 | 0.655 | -0.646 | -0.669 | 0.424 |
| UR | 6.441 | 6.332 | 6.497 | 3.332 | 7.62 |
| R&DGP | 6.808 | 5.977 | 6.719 | 7.726 | 3.826 |
| PAT-ASR | 0.334 | 0.476 | 0.26 | 0.349 | 0.319 |
| PAT-CMPR | 2.164 | 3.869 | 1.264 | 2.126 | 2.183 |
| BTCR | 1.601 | 3.327 | 0.695 | 1.792 | 1.404 |
| HTGEIR | 1.018 | 1.129 | 0.96 | 1.046 | 0.99 |
| NPATG | 2.69 | 2.678 | 2.696 | 0.486 | 4.968 |
| NPATRPOPG | 1.999 | 1.632 | 2.246 | -0.374 | 4.461 |

Tab. CR: Correlation coefficients

| | EIG | VAIG | ILPG | ISY | EXPG | PCG | PFIG | GCG | OSG | WBG | RWG | MEG | MESI | MESIG | 1SYJ | EEXRG | UR | R&DGP | PAT-ASR | PAT-CMPR | BTCR | HTGEIR | NPATG | NPATRPOPG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EIG | 1 | 0.655 | -0.027 | 0.348 | 0.491 | 0.614 | 0.772 | 0.402 | 0.315 | 0.763 | 0.269 | 0.724 | -0.23 | 0.241 | 0.226 | -0.0205 | -0.299 | 0.174 | 0.203 | 0.232 | 0.209 | 0.035 | 0.0102 | -0.06 |
| VAIG | | 1 | 0.738 | 0.505 | 0.712 | 0.824 | 0.67 | 0.523 | 0.461 | 0.822 | 0.657 | 0.544 | -0.356 | 0.043 | 0.39 | 0.121 | -0.442 | 0.42 | 0.21 | 0.205 | -0.0125 | -0.11 | 0.058 | 0.004 |
| ILPG | | | 1 | 0.357 | 0.503 | 0.542 | 0.197 | 0.333 | 0.328 | 0.406 | 0.629 | 0.073 | -0.265 | -0.158 | 0.314 | 0.178 | -0.318 | 0.399 | 0.097 | 0.064 | -0.203 | -0.176 | 0.068 | 0.06 |
| 1SY | | | | 1 | 0.537 | 0.499 | 0.285 | 0.495 | 0.005 | 0.54 | 0.503 | 0.232 | -0.238 | 0.018 | 0.749 | 0.283 | -0.545 | 0.44 | 0.325 | 0.276 | -0.378 | -0.423 | -0.034 | -0.075 |
| EXPG | | | | | 1 | 0.584 | 0.375 | 0.405 | 0.188 | 0.668 | 0.57 | 0.255 | -0.328 | -0.0725 | 0.344 | -0.191 | -0.492 | 0.465 | 0.185 | 0.095 | -0.061 | -0.102 | 0.013 | -0.034 |
| PCG | | | | | | 1 | 0.646 | 0.53 | 0.426 | 0.852 | 0.736 | 0.488 | -0.267 | -0.0306 | 0.294 | 0.141 | -0.422 | 0.427 | 0.161 | 0.099 | -0.053 | -0.133 | -0.13 | -0.18 |
| PFIG | | | | | | | 1 | 0.321 | 0.423 | 0.728 | 0.414 | 0.866 | -0.107 | 0.169 | 0.224 | 0.135 | -0.182 | 0.293 | 0.067 | 0.082 | -0.012 | -0.124 | 0.135 | 0.083 |
| GCG | | | | | | | | 1 | -0.058 | 0.635 | 0.597 | 0.152 | -0.493 | -0.194 | 0.237 | 0.081 | -0.539 | 0.411 | 0.024 | 0.009 | -0.181 | -0.295 | -0.224 | -0.264 |
| OSG | | | | | | | | | 1 | 0.21 | 0.039 | 0.385 | 119 | 0.107 | 0.125 | 0.085 | 0.228 | 0.12 | -0.022 | -0.022 | -0.067 | -0.153 | 0.299 | 0.278 |
| WBG | | | | | | | | | | 1 | 0.827 | 0.564 | -0.389 | -0.0075 | 0.241 | 0.048 | -0.59 | 0.436 | 0.093 | 0.048 | -0.084 | -0.163 | -0.183 | -0.242 |
| RWG | | | | | | | | | | | 1 | 0.211 | -0.381 | -0.221 | 0.163 | 0.09 | -0.62 | 0.498 | -0.038 | -0.131 | -0.307 | -0.274 | -0.281 | -0.307 |
| MEG | | | | | | | | | | | | 1 | -0.051 | 0.639 | 0.185 | 0.1 | -0.045 | 0.171 | 0.032 | 0.098 | 0.009 | -0.097 | 0.146 | 0.1 |
| MESI | | | | | | | | | | | | | 1 | 0.0625 | -0.187 | -0.162 | 0.449 | -0.224 | -0.00547 | -0.114 | 0.0442 | 0.102 | 0.198 | 0.233 |
| MESIG | | | | | | | | | | | | | | 1 | 0.019 | -0.0109 | 0.191 | -0.113 | -0.039 | 0.0685 | 0.0373 | -0.0003 | -0.0798 | 0.069 |
| 1SYJ | | | | | | | | | | | | | | | 1 | 0.439 | -0.347 | 0.24 | 0.652 | 0.629 | -0.128 | -0.213 | 0.222 | 0.195 |
| EEXRG | | | | | | | | | | | | | | | | 1 | -0.284 | 0.035 | 0.369 | 0.454 | 0.003 | 0.077 | 0.092 | 0.092 |
| UR | | | | | | | | | | | | | | | | | 1 | -0.405 | -0.368 | -0.311 | 0.069 | -0.025 | 0.314 | 0.34 |
| R&DGP | | | | | | | | | | | | | | | | | | 1 | 0.055 | -0.019 | -0.299 | -0.314 | 0.003 | -0.024 |
| PAT-ASR | | | | | | | | | | | | | | | | | | | 1 | 0.908 | 0.453 | 0.326 | 0.076 | 0.063 |
| PAT-CMPR | | | | | | | | | | | | | | | | | | | | 1 | 0.513 | 0.414 | 0.112 | 0.92 |
| BTCR | | | | | | | | | | | | | | | | | | | | | 1 | 0.832 | -0.041 | -0.69 |
| HTGEIR | | | | | | | | | | | | | | | | | | | | | | 1 | 0.031 | 0.007 |
| NPATG | | | | | | | | | | | | | | | | | | | | | | | 1 | 0.995 |
| NPATRPOPG | | | | | | | | | | | | | | | | | | | | | | | | 1 |

Chart 1: Productivity regime (I) and demand regime (II) total, E.C., and non- E.C., 1960-1990.

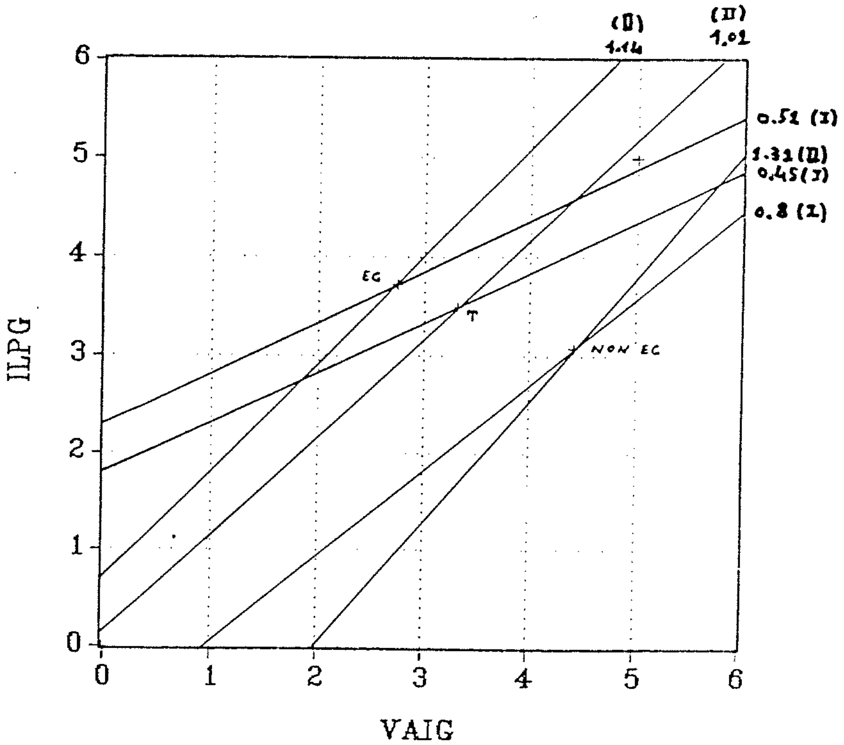



Chart 2: Productivity regime (I) and demand regime (II), 1960-1990, 1960-1976, 1976-1990.