(d) Better advice both to investors at home and to their representatives overseas, in particular through the provision of relevant information;

(e) More contact between embassies and the business world and legal experts in the developing countries in order to provide more effective economic and legal assistance to the investors concerned, in particular those in medium-sized firms;

(f) General support for multilateral efforts to improve entrepreneurial co-operation.

Notes

1/ A.J. Halbach, Deutsche Direktinvestitionen in Entwicklungsländern unter besonderer Berücksichtigung der industriellen Verlagerung (Munich, IFO-Institut für Wirtschaftsforschung, 1977), p. 12.

2/ For further discussion, see Jürgen Riedel and others, "Multilaterale Industriekooperation," IFO-Studien zur Entwicklungsforschung, vol. 7 (Munich, 1980), sects. C.II and C.III.

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MANUFACTURING AS AN ENGINE OF GROWTH - REVISITED

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Introduction

In the early post-war period it was conventional for economists working on the problems of developing countries to assume that industrialization, and in particular manufacturing industry, had a key role to play in the process of long-run growth. This is clear from even a cursory examination of the writings of pioneers in this field, such as Nurskey, Lewis and Prebisch. Furthermore, international cross-sectiional studies produced by Chenery and others revealed a strong association between the sizes of gross domestic product (GDP) and of the manufacturing sector: the natural assumption was that causation ran from the growth of the latter to that of the former. More recently, however, such views have been challenged and much has been written criticizing the type of industrialization that has taken place in developing countries in the post-war period, and in particular questioning its contribution to both growth and wider government objectives [1]. Partly in response to this more critical view of industrialization programmes, emphasis in the planning literature has tended to shift away from the implementation of broad strategies at a macro-economic level towards a more micro-economic approach in which efficiency of individual projects or sectoral plans is examined [1, 2]. Little and Mirrlees, in particular, have written scathingly on the misuse of strategies based on little more than hunches [3].

The object of the present paper is to re-examine the argument that manufacturing has a special role as an "engine of growth", and to discuss some empirical evidence that has recently been collected on this question.** Sutcliffe, in his textbook on industrialization and underdevelopment, cites a number of reasons for giving priority in some way to manufacturing: these include the demand it creates for other sectors through its linkage effects, its ability to earn or conserve foreign exchange, its impact on domestic savings, its employment effect, and the external economies it creates [5]. It should be noted however that none of these effects are necessarily unique to manufacturing and that, in a particular economy at a given time, whether or not they will be stronger for manufacturing than for other sectors will be an empirical question.***

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**It must be stressed that the arguments discussed here do not imply priority for manufacturing at the cost of the neglect of other important sectors. As Baran puts it, "it would seem that what we are faced with is a vicious circle. There can be no modernization of agriculture without industrialization, and there can be no industrialization without an increase of agricultural output and surplus" (Baran [4], p. 277).

***Little, Scitovsky and Scott [1] point out that "infant industry" arguments can also be applied to agriculture.

There is an argument, however, that focuses directly on the special characteristics of manufacturing and has a very long history within economics: it is that manufacturing is the only activity that in the long-run is subject to increasing returns. This view stems from the distinction, conventional in the classical economists, between increasing returns in manufacturing compared with diminishing returns in agriculture, commerce being treated as an appendage of manufacturing. In its modern form the argument was taken up by Allyn Young [6], and expanded and elaborated upon by Kaldor [7, 8]. Cripps and Tarling [9] subjected Kaldor's generalizations to empirical testing, and Cornwall [10] extended and clarified the argument in a number of interesting ways. It should be noted, however, that all of the above works are concerned with the role of manufacturing in the growth of developed capitalist economies. The extension of this line of reasoning to developing countries has come only recently (for example Brailovsky [11] and Brailovsky, Eatwell and Ros [12]).

Manufacturing and increasing returns

Kaldor has provided the fullest statement of this position, and here attention will be focused initially upon his arguments. Kaldor's case starts from the observed statistical correlation, across a number of States members of the Organisation for Economic Co-operation and Development (OECD), between the growth of GDP and the growth of manufacturing; a similar correlation between GDP and other sectoral output is only found in the case of distribution and, as we shall see, Kaldor argues that here the causation is reversed [8].* Such an association is only important if one has a theory to explain what is special about manufacturing to enable it to play the role of an engine of growth. Kaldor's explanation is based on what he terms "dynamic increasing returns in manufacturing". It is not just a question of higher levels of output being associated with lower inputs per unit of output and thus higher productivity; this can be seen as economies of scale in a static sense, and such economies are potentially reversible when output contracts. Kaldor acknowledges that economies of this type will be found in non-manufacturing activities, at least up to some minimum efficient level of output. What he has in mind in the special case of manufacturing is a dynamic relation between the growth of output and the growth of productivity, which is attributable to greater skill developments, or "learning by doing", and to technological improvements. This means that the level of productivity is a function of cumulative output from the commencement of production, rather than the level of output at any one time. Another way of putting this is that continuous reductions in inputs and product quality changes result from continuous increases in output over time. Economies of this type, resulting from greater specialization and from production experience, as well as from technological improvements, should be irreversible.

As a means of testing the hypothesis of dynamic increasing returns in manufacturing, Kaldor used cross-sectional regression analysis to estimate

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*The obvious point that such an association may simply reflect a correlation between a whole GDP - and one of its parts - manufacturing - is countered by Kaldor with the fact that there is also a statistically significant relation between the growth of manufacturing and that of GDP net of the manufacturing sector.

equations (1) and (2) below for a number of different sectors across a sample of developed economies:

$$(1) \qquad p_i = a + bq_i$$

$$(2) \qquad e_i = a + bq_i$$

where q, p and e are the logarithmic growth rates of output, productivity and employment respectively in a given economy and i refers to a given sector.

Equation (1) is the familiar Verdoorn relationship between output growth and productivity growth, which has been found to hold true for many branches of economic activity.* Since by definition, however, $q_i = p_i + e_i$, it is possible to find spurious correlations between q and p, particularly when changes in employment are small. To allow for this, Kaldor argues that the key test for the existence of dynamic increasing returns is not only that equation (1) holds good, but that in addition equation (2) is statistically significant with $b < 1$, implying that while both productivity and employment growth rates increase with output growth, the increase in employment growth is proportionally slower. In Kaldor's original analysis, industry was the only sector for which equations (1) and (2) were both statistically significant.**

It should be noted that the validity of this test has been the subject of debate. First, an alternative interpretation of equation (1) would see causation running from productivity growth to output growth, and would place the explanation for differential rates of productivity growth on autonomously determined rates of technical progress [14]. Kaldor rejects this on the grounds that if one is considering equation (1) across branches within a sector, it would imply that different autonomously determined productivity growth rates would be fully reflected in relative price movements, and that the price elasticity of demand for all the commodities produced by the branches concerned would have to exceed 1.0.***

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*See for example Salter [13]. In Kaldor's original analysis, productivity is defined as output per man-hour at constant prices.

**Industry is defined by Kaldor [8] as manufacturing plus construction and public utilities. Equations (1) and (2) hold true for industry as a sector and for its manufacturing and non-manufacturing components taken separately. Cripps and Tarling [9], however, found the Verdoorn relation to hold true only in manufacturing, although their test differs from that of Kaldor.

***Kennedy, in his survey of the data supporting both possible lines of causation, concluded that:

> "... though it may be impossible to draw any direct conclusions relevant to our analysis from the observed price elasticities, the findings already mentioned about the correlation between changes in productivity and in price, and between changes in price and output, make it difficult, if not impossible, to maintain that the correlation between changes in output and productivity could come about due to the impact of productivity changes or output changes via relative price changes" (Kennedy [15], pp. 182-183).

Secondly, Rowthorn [16] pointed out that ordinary least squares regression techniques, when applied to models such as equations (1) and (2), will give biased estimates when the independent variable, in this case q, is not truly independent of the variables it is meant to explain. Rowthorn suggested that a more direct and satisfactory test would be to take e as the independent variable and to regress p on e. Cornwall [10], however, argued that for developed economies in the post-war period there was strong evidence that the growth of employment in manufacturing was determined by manufacturing output, so that e was itself not independent of the other parameters, and that Rowthorn's alternative was, if anything, less satisfactory.

There is agreement, however, that Rowthorn's procedure is inappropriate where there is a surplus of labour, since employment can adjust to changes in demand, and while it is questionable how far the labour markets of OECD economies in the post-war period can be characterized in this way, it is generally accepted that such conditions are still widely prevalent in developing economies. The conclusion of this particular debate appears to be that while a simultaneous equation estimation procedure may give a more satisfactory test of the hypothesis, if ordinary least squares techniques are to be applied, the Kaldor test is probably as good as any other, and is clearly superior in the labour-market conditions closest to those found in developing countries.*

Before considering some recent evidence on the question of increasing returns in manufacturing in developing countries, it is necessary to examine in more detail the mechanism whereby such dynamic economies might manifest themselves, with a view to clarifying why they are not judged to arise in other sectors. Kaldor himself is less than wholly clear on this question. As already noted, he refers to skill and learning effects in the work-force, and technological progress leading to improvements in techniques of production and the quality of final outputs, as key factors in the process.

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*Kaldor acknowledges that cumulative theories of growth, which will be discussed further below, and upon which his own work has had a major influence, make it difficult to argue that q is wholly independent of p. He maintains however that:

> "In saying that growth is explained by the increase in demand which is 'exogenous' to the growing sectors I am conscious of the fact that this statement is itself a simplification but one which does not invalidate the statistical inferences derived from it. The growth of industrial output for any region is governed in part by the growth in productivity, which itself influences demand through the change in competitiveness which is induced by it. It is this reverse link which accounts for the cumulative and circular nature of growth processes. There is a two-way relationship from demand growth to productivity growth and from productivity growth to demand growth; but the second relationship is, in my view, far less regular and systematic than the first." (Kaldor [17], p. 895, footnote 1.)

The emphasis on specialization, and thus improvements in skill levels in the work-force, is a restatement of Adam Smith's famous dictum that the division of labour depends upon the extent of the market.* There may be less scope for this type of specialization within other sectors, such as agriculture or services, but clearly it must be recognized that possibilities exist in these sectors, as they do in manufacturing.

A more substantial argument can be based upon Young's wider interpretation of the division of labour:

> "No one as far as I know has tried to enumerate all of the different aspects of the division of labour and I do not propose to undertake that task. I shall deal with two related aspects only; the growth of indirect or roundabout methods of production and the division of labour among industries." (Young [6], p. 529.)

More significant than the static economies of large-scale production, according to Young, are those that arise as a result of increasing specialization and differentiation between firms, in particular as an increasingly complex set of supplier industries is established. The scale of these specialist producers is naturally dependent upon the extent of the market for the products for which they provide inputs. Young therefore sees productivity growth in manufacturing as arising primarily from what he terms "increasingly roundabout methods of production", since firms have the opportunity to become more specialized and to reap the advantages of specialization when the manufacturing sector expands.** However he stresses the fact that the nature of the process is such that it is not always possible to observe a relation between productivity growth for a firm or even a branch of industry and output growth at the firm or branch level. Individual firms benefit from the external economies provided by the greater specialization of their suppliers; similarly, at the branch level, the fast growth of a particular branch may have its immediate impact on the productivity of supplier firms located in a different

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*Young pointed out that Smith's conception of the division of labour and specialization came to be widened by later economists:

> "Today, of course, we mean by the division of labour something much broader in scope than that splitting up of occupations and development of specialized crafts which Adam Smith mostly had in mind." (Young [6], p. 529.)

Marx discusses some of the wider implications of the division of labour in capitalist production. (Marx [18], chap. XIV, sect. 4, pp. 350-358.)

**Young cites the case of the printing industry, where a range of specialist producers has taken over tasks previously handled by the printers themselves. He stresses that it is this characteristic of manufacturing which mainly accounts for productivity gains:

> "... the principal economies which manifest themselves in increasing returns are the economies of capitalistic or roundabout methods of production. These economies are largely identical with the economies of the division of labour in its most important modern forms." (Young [6], p. 531.)

branch. In these circumstances, Young argues, it is necessary to see industrial operations as an interrelated whole: this implies that the most appropriate level for testing the hypothesis of increasing returns in manufacturing is that of the aggregate of all manufacturing activities, which is the level at which Kaldor conducted his original analysis.

In addition to Young's arguments on specialization, Cornwall gives a further insight into the mechanism of increasing returns in relation to technological change. Citing the work of Schmookler [19], he argues that activity in the capital goods branches can be an important means of transmitting technological progress to other branches and sectors. If inventions are classified by branch of use, the rate of appearance of inventions may be influenced by recent investment in the using branches, on the grounds that past investment in these branches is an indication to capital goods producers that future demand for equipment from these branches is likely to be strong. The capital goods producers may, therefore, concentrate their applied research on the needs of the user branches, who in the recent past have expanded their capacity significantly; from this research, technical progress and improved equipment may result. Since there is likely to be an association between past output growth and past investment, this hypothesis establishes a link between output growth and technological progress through the responsiveness of capital goods producers. Technological progress is seen as leading to applied technical change, which culminates in productivity growth.* This argument, however, suggests that there may be an association between output and productivity growth at the branch level within manufacturing; nonetheless, it provides no basis for such an association at the firm level.

A variant of this argument follows Arrow [20] on the question of learning by doing, with particular reference to capital goods producers. In this view, learning may take place in capital goods production as the result of an expansion of cumulative output and growing experience in these branches; investment growth will stimulate the demand for capital goods, and the learning experience among producers of these goods will be spread widely within the economy through purchases of cheapened or improved capital equipment.**

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*Cornwall distinguishes between technological progress - the discovery of inventions - and technical progress - their actual application. (Cornwall [10], p. 129.)

**Consistently with this position, Kaldor [21] argues that, while technical progress embodied in the form of new investments in fast-growing industries plays a role in the process whereby high output growth is related to high productivity growth, this role is a relatively minor one unless it is combined with increasing returns. This is because the process identified is one of accelerating productivity growth in the faster growing industries, and while the latter may attract more investment, it will only ensure continually accelerating productivity growth in these industries if the rate of technical progress over successive vintages of capital is itself accelerating. In other words, it is not a case of more investment per se causing accelerating productivity growth; the investment must embody new technologies and thus be subject to increasing returns.

It must be stressed that Cornwall's argument on technological improvements as a mechanism for transmitting productivity growth is directed explicitly at developed capitalist economies. It is obvious that where capital goods producers do exist in developing countries one cannot expect original theoretical research to emerge in response to demands for more equipment: what will be relevant will be adaptations of and improvements to known, chiefly imported, technologies. While this transmission mechanism is clearly of a qualitatively different type to that envisaged for developed economies, there is substantial historical evidence to suggest that "late-comer" economies can make substantial gains in production efficiency through the adaption of imported technology, provided they have a minimum initial base in terms of an equipment-producing industry and a skilled labour force.

The view of the uniqueness of manufacturing that emerges from this discussion can be summarized as follows:

(a) Manufacturing, unlike the other major sectors - agriculture and services, is characterized by increasingly interrelated and specialized branches of activity. To use Young's terminology, it has the potential for a high degree of roundaboutness in its production structure and thus, when its aggregate output expands, there is a far greater scope for the division of labour and specialization within the sector itself than is the case for the other sectors. In other words, in input-output terms, manufacturing has potentially much higher intrasectoral linkages;

(b) The manufacturing sector produces the capital equipment used by all sectors. Endogenous technical progress within manufacturing induced either by its own expansion or by the expansion of other parts of the economy, will feed back to all users of capital equipment and thus raise the technical level of all sectors.

Clearly this is not meant to imply that agriculture or services do not have strong linkages - backward or forward - with other sectors. The point is that the expansion of these sectors does not offer the same scope for division of labour and specialization within the sectors themselves: furthermore, technical change in these sectors is not passed on as it would be through the purchase of capital equipment. It should, however, be made clear that this line of reasoning does not minimize the role that can be played by agriculture in the growth process. Kaldor [8], for example, stresses the importance of agriculture at an early stage of economic development both as a supplier of wage goods and as a market for industrial products. Furthermore, he does not deny that agriculture can experience rapid productivity growth; what he suggests, however, is that this productivity growth results from technical innovations or institutional changes which raise yields per acre. It does not require an acceleration in the growth of sectoral output to allow a greater division of labour within agriculture; in other words, more specialized agricultural inputs are not required to allow the expansion of agricultural output. Kaldor takes as proof of this the fact that equation (2) does not hold true for agriculture in the sample of developed economies he examined; therefore while there is a relation between output and productivity growth - and equation (1) is statistically significant - this output growth does

not require the employment of more workers in the sector.* In developing countries, there is clearly the possibility that productivity in agriculture may be negatively associated with employment growth if surplus workers in agriculture are absorbed by an expanding manufacturing sector.

Similar arguments apply to services. Most of Kaldor's comments are directed towards distribution; he found a high correlation between the growth of the sector and that of GDP across the group of developed countries in his sample, but argues that the growth of distribution simply reflects the growth of commodity production, so that causation runs from the growth of GDP to that of sectoral output. Furthermore, he suggests that even in developed countries, but clearly much more so in developing ones, there is a large potential for increasing the output of the distribution sector with a given labour force; this implies that productivity improvements in distribution will largely be a response to the growth of production in the primary and secondary sectors. As with agriculture, Kaldor accepts the possibility of productivity growth in services through static economies of large-scale production, such as those resulting from the introduction of supermarkets, but distinguishes these from the dynamic economies arising from an extension of the division of labour in manufacturing.

In summary, Kaldor sees manufacturing acting as an engine of growth, since its growth will raise productivity not just in the sector itself, through an extension of the division of labour, but also in the other major sectors; productivity is likely to rise in agriculture through the absorption of surplus workers off the land, and in services because of the increased output of the distribution sector. Further productivity gains and technical progress in manufacturing will be passed on to other sectors through their purchases of capital and intermediate goods. It should be noted, however, that Kaldor [17, 21] argues that the engine-of-growth view of manufacturing will hold true whether or not it is subject to what he terms "dynamic increasing returns". This is on the grounds that an expansion of investment and production in manufacturing will generate the profits to finance further growth, and surplus workers from agriculture or services can be employed in manufacturing with no loss of output elsewhere. In other words, the argument is that the opportunity cost of investment finance and labour for manufacturing will be zero, or at least low. One might dispute the realism of the analysis underlying this view of manufacturing expansion, but even if the opportunity costs involved are very low, similar arguments could be applied to capitalist development in agriculture or some service branches, such as tourism; investments in these areas could also generate their own investment surpluses and employ surplus workers. The case for the engine-of-growth view seems to hinge,

*Kaldor [8] points out that in the developed economies that have specialized in agriculture, the sector employs only a relatively small proportion of the working population. His point is that a developing economy that chose to specialize in agriculture alone and to import its requirements of industrial goods might achieve a high level of output in relation to the numbers employed in agriculture, but that agricultural expansion would employ only a small portion of the work-force, since the possibilities for specialization within agriculture to supply its needs for inputs are limited.

therefore, on the validity of the hypothesis regarding the existence of dynamic increasing returns in manufacturing. Naturally one would expect this phenomenon to be weaker in the case of developing countries because of their far lower level of industrialization. It has, however, been argued recently that substantial capitalist development - particularly in the industrial sector - has taken place in these economies in the last two or three decades [22]. It may be appropriate, therefore, to consider how far this industrialization has exhibited a tendency towards dynamic increasing returns, which the Young-Kaldor argument suggests played such a key role for the present developed economies.

Empirical evidence of increasing returns in manufacturing

Apart from Kaldor's original statistical analysis, work to test his generalizations for developed economies has been conducted by, among others, Cripps and Tarling [9] and Cornwall [10].* It is only quite recently that the analysis has been extended to developing countries. Brailovsky [11] demonstrated the importance of manufacturing in the Mexican economy. He obtained similar results to those of Cripps and Tarling for developed economies, in that the correlation between sectoral output growth and growth of GDP was high only for manufacturing and commerce (see table 1). In the case of manufacturing, this was not because it was an important component of GDP, since a significant correlation was also found between manufacturing growth and growth of GDP net of manufacturing.** Brailovsky tested equations (1) and (2) using time series

*Rowthorn [16] pointed out that Cripps and Tarling's conclusion regarding the existence of dynamic increasing returns in manufacturing is dependent upon the inclusion of Japan, which he argued was a special case of a late-comer economy, in their sample of countries. Kaldor [17] replied that Cripps and Tarling's test of regressing productivity on employment was inappropriate and that using his test (equations (1) and (2)), significant results were obtained with the exclusion of Japan.

**The regression coefficient for the relation between manufacturing and GDP growth was less than 1, supporting the assertion by Kaldor [8], that the overall growth rate of an economy will be higher in proportion to the excess of the growth of manufacturing over that of other sectors (t-ratios in parentheses):

$$y = 0.01 + \underset{(8.78)}{0.75}\ \bar{q}_m + \underset{(9.50)}{0.73}\ (q_m - \bar{q}_m)$$

$$R^2 = 0.90;\ D.W. = 1.48$$

where y is the growth of GDP, $\bar{q}_m$ is the long-run trend growth of manufacturing and q_m is the actual growth of manufacturing

See Brailovsky [11] for an explanation of the calculation of $\bar{q}_m$. The regression coefficient of $\bar{q}_m$, which equals 0.75, represents the long-run elasticity of GDP with respect to manufacturing.

data on manufacturing and found both to be statistically significant. He comments that time series data on employment were not available to extend the analysis to other sectors; however, a rough test was carried out by the present author using cross-sectional data on employment, output and productivity across 45 Mexican branches. For the period 1960-1973, equations (1) and (2) are both statistically significant for 20 manufacturing branches, but only equation (1) holds good for non-manufacturing. In other words, outside manufacturing there was no relation between the expansion of production and employment growth and thus, using Kaldor's test, there was no evidence for the existence of dynamic increasing returns.*

Table 1. Correlation of the rate of growth of output in various sectors with the growth of GDP (Coefficient of determination R^2)

Sector	Twelve OECD countries (1950-1970)	Mexico[a/] (1960-1978)
Manufacturing	0.90	0.81
Construction	0.70	0.58
Public utilities	0.16	0.34[b/]
Agriculture	0.04	0.32
Mining	0.00	0.01
Transport	0.66	0.29
Commerce	0.85	0.95
Other services	0.40	0.56

Source: For OECD countries, Cripps and Tarling [9], table 3.1; for Mexico, Brailovsky [11], table 2.

a/ The regressions are time series.

b/ Electricity only.

*The forms of equation (2) (t-ratios in parentheses) are:

Manufacturing (1960-1973)

$$e = 0.20 + 0.43q$$
$$(3.50)$$
$$R^2 = 0.39; \quad n = 20$$

Non-manufacturing (1960-1973)

$$e = 0.52 - 0.17q$$
$$(0.16)$$
$$R^2 = 0.05; \quad n = 25$$

The coefficients were calculated by the author from data supplied by the Ministry of Industry and Natural Resources, Mexico City.

Data have also been compiled to allow testing for the existence of dynamic increasing returns in manufacturing for groups of developing and developed economies [12]. A study was made of 31 countries, 16 developing and 15 developed, over two separate international cycles, 1965-1973, and 1973-1978.* A number of interesting points emerge from an examination of these data.

First, the relatively close relation between the growth of manufacturing and the growth of GDP holds good for the group of developing as well as developed economies, although neither group has a correlation coefficient as high as that found by Cripps and Tarling (see table 2). There is a slight tendency for the correlation coefficients and significance of the regression coefficients to be higher for the group of developing countries.

Table 2. Cross-country regressions between rates of growth of GDP y and manufacturing output q_m by groups of countries, national peak years

Country group	1965-1973 a	1965-1973 b	1965-1973 R^2	1973-1978 a	1973-1978 b	1973-1978 R^2
All countries	1.72	0.58 (9.78)	0.77	2.58	0.42 (6.46)	0.59
Developing countries	2.02	0.56 (6.71)	0.75	2.67	0.42 (5.05)	0.65[a/]
Developed countries	1.55	0.58 (5.37)	0.71	1.79	0.58 (4.02)	0.59[b/]

Source: Brailovsky, Eatwell and Ros [12], table 2.1.

Notes: 1. Form of equation: $y = a + bq_m$
2. Figures in parentheses are t-ratios.

a/ Excluding Venezuela.

b/ Excluding Norway.

*For individual countries, data were calculated between national peak years within the overall international cycles 1965-1973 and 1973-1978. The developing countries in the sample were those in which the manufacturing sector has surpassed a certain minimum absolute size. The precise criteria used to select the countries were not given in the original paper.

Secondly, for developing countries, equations (1) and (2) were found to be statistically significant for manufacturing in both periods examined, although for developed countries the increasing returns relationship appears to have broken down in the second period, since equation (2) was not significant, and equation (1) only weakly so (see table 3).* It is important to note that from equation (1) a given rate of growth of manufacturing output is associated with a lower rate of productivity increase and a higher rate of employment growth in developing as opposed to developed economies. This is consistent with the explanation given above for the transmission of increasing returns and productivity growth throughout manufacturing. It is obvious that manufacturing sectors in developing countries are far less integrated than they are in developed economies, in the sense that the degree of specialization has been carried much less far, and a higher proportion of manufactured goods is provided from outside manufacturing itself in the form of imports; smallness of the capital goods sector is a particular manifestation of this lack of integration, which would suggest that the benefits of the division of labour within manufacturing are more difficult to acquire for developing economies.**

Nonetheless, the statistical significance of equations (1) and (2) can be interpreted as implying that the limited degree of industrialization that has taken place in these economies has led to some specialization and productivity gains and that manufacturing is beginning to play a similar role to the one it played in the past development of today's developed economies.

Thirdly, perhaps one of the most interesting aspects of the data is that they provide support for the argument of Allyn Young that productivity growth is a "macro" phenomenon. This proposition implies that for any individual branch productivity performance will be affected significantly by the behaviour of the whole of the manufacturing sector in the country in which it is located. One test of this is to compare, for each branch, the ranking of countries by productivity growth with the ranking of the same countries in terms of productivity growth in manufacturing in the aggregate. If the proposition is valid, one would expect significant

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*The authors suggest that this may be due, at least in part, to "degenerate productivity growth", in the sense that, as a result of the recession, in certain branches in the industrialized countries productivity rises as output and employment fall when inefficient or marginal producers are closed. If the more successful producers acquired their extra workers from within manufacturing as labour moved out of marginal firms, this would help further to explain the non-significance of equation (2).

**This important point will be taken up further below. It should be noted that this conclusion, namely that the benefits in terms of productivity for a given rate of output growth in manufacturing are lower in developing than in developed economies, is at variance with explanations of productivity growth based on "catching-up" theories of technology borrowing [16].

Table 3. Cross-country regressions on equations (1) and (2) for the manufacturing sector

Country group	Equation (1) ($P_m = a + bq_m$)						Equation (2) ($e_m = a + bq_m$)					
	1965–1973			1973–1978			1965–1973			1973–1978		
	a	b	R^2	a	b	R^2	a	b	R^2	a	b	R^2
All countries	2.01	0.33 (3.55)	0.30	0.54	0.45 (4.92)	0.45	-2.01	0.66 (6.93)	0.62	-0.54	0.55 (6.04)	0.56
Developing countries	0.67	0.38 (4.13)	0.53	-0.48	0.54 (4.80)	0.60	-0.67	0.62 (6.71)	0.75	0.48	0.46 (4.12)	0.53
Developed countries	1.36	0.68 (6.56)	0.78	1.05	0.60 (2.01)	0.25	-1.36	0.32 (3.07)	0.43	-1.04	0.34 (1.05)	0.08

Source: Data compiled by the Ministry of Industry and Natural Resources, Mexico City, for Brailovsky, Eatwell and Ros; partly reported in Brailovsky, Eatwell and Ros [12], table 2.2.

Note: Figures in parentheses are t-ratios.

rank correlation coefficients, implying that countries with fast rates of productivity growth in total manufacturing also do relatively well in individual industries. The authors found significant rank correlation coefficients in 9 out of 12 industrial branches in the first period, and in 11 out of 12 in the second. They also looked at the variance of productivity growth rates both between individual branches within a particular country and within particular branches across countries. If the "macro" phenomenon hypothesis holds, one would expect a substantially lower variance of productivity growth within individual countries; this was also confirmed.

A final piece of evidence can be obtained by extending the authors' original analysis and looking at the forms of equations (1) and (2) for individual branches across countries where productivity and employment growth in a branch are regressed on output growth in the same branch; these results can be compared with similar regressions across countries for manufacturing as a whole. The results for the group of developing countries are given in table 4. It can be seen that for equation (1), the coefficient of determination R^2 and the significance (t-ratio) of the regression coefficient are higher for 5 out of 13 individual branches than for manufacturing in the aggregate in the period 1965-1973, and for 3 out of 13 in the period 1973-1978. In the case of equation (2), however, on which it will be recalled that Kaldor places great stress, in the first period the values of R^2 and the t-ratio are higher for only 1 of the 13 branches than for manufacturing as a whole, while for the second period these parameters are higher for manufacturing in the aggregate than for any of the individual branches. This suggests that, with a few exceptions, the equations underlying the phenomenon of dynamic increasing returns to manufacturing are statistically more significant when one looks at total manufacturing rather than at the behaviour of individual branches.*

Obviously, results such as those are not comprehensive enough to establish conclusively the validity of generalizations such as those contained in the engine of growth hypothesis discussed here. However, within the limitations of the test suggested by Kaldor, there is evidence that the manufacturing sector, in developing countries where industrialization can be seen as having passed some threshold limit, exhibits tendencies towards dynamic increasing returns that are similar to (if weaker than) those observed in the past in developed economies. The implications of this phenomenon are taken up in the final section.

Implications of the engine-of-growth hypothesis

The most direct implication of this view of the process of growth is by no means new. The engine-of-growth hypothesis in the form discussed here is really a restatement of what were once regarded as conventional views on the importance of industrialization. Young states that:

> "... the mechanism of increasing returns is not to be discerned adequately by observing the effects of variations in the size of an individual firm or of a particular industry for the progressive division and specialization of industries is an essential part of the process by which increasing returns are realized. What is required is that industrial operations be seen as an inter-related whole."*

*In fact, for most branches equation (2) is not statistically significant, suggesting the relevance of externalities at the sectoral level rather than the branch level.

Table 4. Cross-country regressions for branches of the manufacturing sector in 16 developing countries

A. Equation (1)

Branch	1965-1973 a	1965-1973 b	1965-1973 t-ratio	1965-1973 R^2	1973-1978 a	1973-1978 b	1973-1978 t-ratio	1973-1978 R^2
Food, drink and tobacco	-1.38	0.75	6.13	0.71	-0.94	0.63	3.62	0.47
Textiles	-0.27	0.50	3.36	0.43	-0.93	0.62	5.97	0.70
Wood	-0.16	0.69	4.51	0.57	2.59	0.67	3.89	0.50
Paper	1.30	0.29	2.00	0.21	-0.71	0.58	3.18	0.40
Chemicals	3.97	0.07	0.32	0.00	-0.52	0.40	2.41	0.28
Petrochemicals	-4.42	0.84	6.61	0.74	-4.13	0.81	2.98	0.37
Non-metallic minerals	0.83	0.36	2.48	0.29	-0.78	0.63	3.39	0.43
Basic metals	-1.34	0.50	2.68	0.32	-1.62	0.74	2.93	0.36
Metal products	0.67	0.50	2.08	0.22	0.51	0.73	5.24	0.65
Non-electrical machinery	-7.77	0.99	8.64	0.83	-3.97	1.01	4.38	0.56
Electrical machinery	4.46	0.11	0.98	0.06	1.20	0.53	4.16	0.53
Transport equipment	-0.81	0.77	5.07	0.63	-0.08	0.92	5.50	0.67
Others	-0.43	0.33	1.18	0.08	4.53	0.20	0.61	0.02
Total manufacturing	0.67	0.38	4.13	0.53	-0.48	0.54	4.80	0.60

continued

Table 4 (continued)

B. Equation (2)

Branch	1965-1973 a	b	t-ratio	R^2	1973-1978 a	b	t-ratio	R^2
Food, drink and tobacco	1.38	0.25	2.03	0.21	0.94	0.37	2.15	0.24
Textiles	0.27	0.50	3.35	0.43	0.93	0.38	3.70	0.48
Wood	0.16	0.31	2.00	0.21	-2.59	0.32	1.88	0.19
Paper	-1.30	0.70	4.81	0.61	0.71	0.42	2.29	0.26
Chemicals	3.97	0.93	4.52	0.58	0.52	0.60	3.67	0.47
Petrochemicals	4.42	0.16	1.26	0.09	4.13	0.19	0.70	0.03
Non-metallic minerals	-0.83	0.64	4.39	0.56	0.78	0.37	2.00	0.21
Basic metals	1.34	0.50	2.68	0.32	1.62	0.26	1.04	0.07
Metal products	-0.67	0.50	2.10	0.22	-0.51	0.27	1.91	0.19
Non-electrical machinery	7.77	0.01	0.06	0.00	3.97	-0.01	-0.06	0.00
Electrical machinery	-4.46	0.88	7.46	0.79	-1.20	0.08	0.49	0.02
Transport equipment	0.81	0.22	1.48	0.13	0.08	0.08	0.49	0.02
Others	0.43	0.67	2.37	0.27	-4.53	0.80	2.40	0.28
Total manufacturing	-0.67	0.62	6.71	0.75	0.48	0.46	4.12	0.53

Source: Data compiled by the Ministry of Industry and Natural Resources, Mexico City, for Brailovsky, Eatwell and Ros [12].

This statement, the last sentence of which deserves special emphasis, is very close to the case for industrialization based on its effects external to individual firms, which has been made by many development economists of varying intellectual positions, the point being that one needs to plan for an integrated industrial expansion rather than looking at the possibility of establishing individual industrial projects.

Two qualifications must, however, be made to the argument as it has been presented up to this point. First, as many commentators have pointed out, simple parallels between the behaviour of the manufacturing sectors in developed and developing economies can be highly misleading. It is a well-known fact that in most developing countries the extent of intermediate and capital goods production is relatively small. This structural imbalance in comparison with the position in developed economies may be due to a variety of factors, including difficulties in acquiring and assimilating foreign technologies, the relatively small size of potential markets for these commodities and lack of finance either in domestic or in foreign currency. Since the increasing differentiation of production and accumulation of experience in these branches is the main mechanism through which dynamic increasing returns in manufacturing are said to operate, difficulties in establishing these branches in developing countries will obviously weaken the impact of the dynamic economies associated with manufacturing expansion. There are, however, at least two possible reactions to this situation. One, which is based on calculations of short-run allocative efficiency, would suggest concentrating resources only on the domestic production of intermediate and capital goods in which a developing economy has a reasonable chance of becoming internationally competitive in the short run. Little and Mirrlees, two of the most influential advocates of this approach, gave it the label "trade in intermediates". The alternative strategy would be to override short-run efficiency considerations on the assumption that in the long run the establishment of a more integrated industrial structure would produce dynamic gains both for manufacturing and for the whole economy. The differences in approach stem in part from a difference in time perspective and in part from a different interpretation of the importance of externalities in manufacturing.**

*Quoted from Young [6], p. 529.

**Young's comments on the time perspective in which industrialization programmes must be viewed are again of interest:

"... it would remain a process requiring time. An industrial dictator with foresight and knowledge could hasten the pace somewhat, but he could not achieve an Aladdin-like transformation of a country's industry, so as to reap the fruits of a half-century's ordinary progress in a few years. The obstacles are of two sorts. First the human material which has to be used is resistant to change .... Second the accumulation of the necessary capital takes time, even though the process of accumulation is largely one of turning part of an increasing product into forms which will serve in securing a further increase of product." (Young [6], p. 534.)

This leads to the second qualification. Economists, and not only those writing from a neoclassical position, have been rightly critical of the vagueness with which arguments relating to externalities have been put forward.* This vagueness led Little and Mirrlees [3] to suggest that, even if external effects were important for industrial investments, they were difficult to identify, at least at the level of the individual project; thus, if it could be assumed that they were of roughly equal importance for all industrial investments, they could be safely ignored. It is argued here that the engine-of-growth hypothesis taken largely from Kaldor and Young provides a more convincing view of externalities in manufacturing than do previous statements of this position, and that empirical work following this approach has provided evidence on the existence of externalities attached to manufacturing in the aggregate.** This is still, however, not enough for detailed planning purposes. Relatively large numbers of industrial branches come under the general categories of capital and intermediate goods, and planners need guidance on how to maximize the external benefits, in terms of productivity growth and technical change, arising from an industrialization programme. In this sense, Little, Scitovsky and Scott [1] are clearly correct in pointing out the need to identify which branches are most likely to stimulate these dynamic gains. Also, it is clear that short-run costs in terms of allocative efficiency cannot simply be ignored and some balance must be struck between such costs and dynamic long-run gains. If the general reasoning of the engine-of-growth hypothesis is correct, there remains a major area for research here, in terms of clarifying the mechanisms through which increasing returns arise and linking them with projects in particular branches.

Returning to the question of the implications of the hypothesis, a second broad implication relates to the interpretation of the nature of growth. Several economists have pointed to growth's cumulative or self-reinforcing characteristics.*** The engine-of-growth hypothesis, as

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*For example, Sutcliffe writes that:

> "Industrial as opposed to other kinds of investment, it is argued, is most effective in stimulating new attitudes towards technology, economic incentives and the idea of growth and social change. Even if it is true the argument in this form is seldom more than vague. Where it is given economic support this often involves its proponents waving at their critics blank cheques, signed by influential economists, and drawn on the bank of external economies." (Sutcliffe [5], p. 84.)

**The case put forward here for an integrated expansion of a manufacturing sector emphasizing intrasectoral linkages specialization, applied research and learning is similar in many respects to the "basic materials' strategy" suggested by Thomas [23], although Thomas does not draw upon the Kaldor hypothesis for his evidence.

***Myrdal [24] used the term "cumulative causation" to explain widening income inequalities between regions or national economies. This term has been adopted in several recent studies; see for example Cripps and Tarling [25].

discussed here, has as one of its key elements the view that technological progress and the resulting productivity growth are endogenous to the growth process; this is in contrast to models in which technological progress is given exogenously. If fast growth of output in manufacturing can generate technical change and productivity growth, this will provide a mechanism for improving an economy's international competitive position, either in price or non-price terms, thus relieving its balance-of-payments constraint; the removal of the latter will in turn allow faster growth and so the cumulative process may continue. This interpretation of the nature of growth provides an argument for stimulating a rapid growth of the manufacturing industry through government expenditure, or through expansionary fiscal and credit policies. Such a strategy will naturally have major implications for trade policy, because fast growth of domestic demand, even if it raises productivity in the medium or longer term, will have a negative short term effect on the balance of payments. One possibility is to attempt to create export-led growth through various fiscal incentives and an appropriate exchange-rate policy. If, however, one is sceptical of the possibility of a developing country raising its non-traditional exports significantly in the short run, one must return to some form of import control as the major means of protecting the trade balance from the potential import demand created by rapid domestic expansion. This line of reasoning can be seen as an extension of the familiar infant-industry case for protection. While the latter related improved productivity in a particular industry to time, the argument presented above would add the rate of growth of output in the industry itself and that of manufacturing in the aggregate as key explanatory variables. In a sense, therefore, one has an "infant economy" rather than a specifically infant-industry case for protection.

The cumulative or potentially self-supporting nature of growth can be expressed formally in a number of relations.* As already noted, the key link is between output growth and productivity improvements; productivity

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*One possibility is expressed in equations (3)-(6) below:

(3) $q = a + b_1 I + b_2 x$

(4) $x = a + b_1(p_d - p_f) + b_2(P_d - e - P_f) + b_3 z$

(5) $m = a + b_1(p_f - p_d) + b_2(P_f + e - P_d) + b_3 y$

(6) $p_d = a + b_1 q$

where q, x and m are the growth rates of manufacturing output, exports and imports respectively,

z and y are the growth rates of world and domestic income respectively,

I is the growth rate of total investment,

p_d and p_f are the growth rates of domestic and foreign manufacturing productivity respectively,

P_d and P_f are the growth rates of domestic and foreign manufacturing prices respectively,

e is the movement of the exchange rate.

Equation (3) states that growth rate of manufacturing output is deter-

mined gains will affect price or non-price trade competitiveness, or both. Dixon and Thirlwall [26] and Thirlwall [27] have given formal models of this new version of the cumulative causation view of growth, using relative prices alone as a competitive explanatory variable for export performance.* Thirlwall [27] shows that a model employing the Verdoorn relationship between output and productivity will produce a higher growth of national income consistent with balance-of-payments equilibrium than a model without the assumed link between output and productivity growth, provided the Marshall-Lerner condition is fulfilled. It should be noted, however, that Thirlwall's exposition leaves initial causation unexplained; the process appears to be set off by a windfall gain in competitiveness in particular exports - perhaps as a result of exogenous technical progress; an alternative explanation is that growth of the internal market creates this improved competitiveness through relative productivity growth.**

Perhaps few would dispute that, potentially at any rate, growth can create an environment favourable to further expansion. It is clear that an initial expansionary stimulus can become self-sustaining if the increasing-returns phenomenon is operative, so that higher productivity gives a boost to exports, or to internal demand through the incentive to invest. Naturally growth is not inevitably self-sustaining and a range of

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by the growth rate of total investment and of the export demand for manufactures. Since manufacturing, it is hypothesized, is a key factor in explaining growth of GDP, it would be inappropriate to include y as a separate explanatory variable for q. Equation (4) makes the export growth rate a function of two alternative competitive variables - one of which can be omitted if it is insignificant, or, as is likely, there is multicollinearity - plus the growth rate of world income. Equation (5) is a similar function for imports with the income term now relating to domestic income. Equation (6) is the Verdoorn relation linking the growth rates of productivity and output.

It is necessary to establish a link between productivity and prices through a price mark-up equation so that

$$(7) \qquad P_d = w - P_d + m,$$

where w is the rate of growth of wages and m is the growth rate of the percentage mark-up on labour costs.

Finally, one may add a balance-of-payments constraint so that $x = m$ over a given period.

*Cripps and Tarling [25] derived a series of propositions from the cumulative view of growth, which they tested against the post-war experience of a number of developed economies. One of their findings was that relative price changes had no observable association with changes in export market shares. They found relative growth rates for internal markets, with their associated productivity effects, to be more significant competitive variables.

**See Thirlwall [27], pp. 264-273.

possible bottle-necks - internal and external - may frustrate the process.* The greatest differences of interpretation are likely to arise over the nature of these constraints. Kaldor [8] for example, suggests that scarcity of foreign exchange would be the key bottle-neck, while others might consider domestic savings as the only real gap to be covered.**

While these issues cannot be discussed in full here, some evidence can be put forward which, superficially at least, supports elements of the cumulative causation case. For example, one can compare the relative performance of countries in different international cycles; taking a group of 16 developing countries and ranking them in terms of growth of manufacturing production at constant prices for two separate periods 1965-1973 and 1973-1978, there is a positive rank correlation coefficient of 0.56. A similar exercise for a group of 15 developed countries gives an even higher rank correlation coefficient of 0.79.*** These results suggest that there is an association between relatively good performance over one cycle and a good performance in a subsequent period.

Another indirect test of one of the main elements of the cumulative causation view of growth is first to establish a link between output growth and productivity growth, and secondly to relate productivity growth to export performance. As was noted above, the author found equations (1) and (2) to hold true in a cross-sectional analysis over 20 branches of Mexican manufacturing industry. An export function, including Mexican productivity growth for each branch in relation to a weighted average of productivity growth in the same branch for trade competitors, was used to

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*Baran makes this point clearly in a passage in which he anticipated many of the arguments raised here:

> "While the investment snow-ball effect is clearly synonymous with economic development and necessarily implies the appearance of external economies, the emergence of facilities that could give rise to external economies need not by any means result in increased investment and in general economic growth. To put it differently, synchronized acts of domestic investment reflecting increased division of labour and causing a cumulative widening of internal markets create as a by-product external economies; that is conditions which in turn facilitate further division of labour and further investment. However for this improvement of conditions for investment to result actually in further investment, economic and social development must have reached a stage in which there is the possibility for a transition to industrial capitalism." (Baran [4], p. 191.)

**Kaldor [28] gives the distributional model underlying this position; investment is taken to increase profits, so that the savings necessary to finance investment are generated in the growth process itself.

***The groups of countries studied are those examined in Brailovsky, Eatwell and Ros [12]. Both rank correlations are significant at the 95 per cent level. Data for this exercise were collected at the Ministry of Industry and Natural Resources, Mexico City. As noted earlier, individual country cycles within the two periods are used to calculate growth rates.

attempt to explain the growth of Mexican exports to the United States of America in relation to total United States imports in individual branches. Relative productivity growth proved to be a statistically significant explanatory variable when combined with the initial share of Mexican imports in the United States market for each branch for the cycle 1965-1973; over the more recent period 1973-1978, however, it proved to be less significant.*

These results suggest that in Mexico output may be linked to productivity and productivity to export in the cumulative process.

In concluding this survey of the engine-of-growth hypothesis regarding the manufacturing sector, it is important to stress again the fact that the ideas discussed are familiar ones, expressed, perhaps, in a slightly different form. It is suggested, however, that the Young-Kaldor arguments provide a sharper focus for some of the standard views on the role of industrialization. The neo-classical interpretation of industrialization, as exemplified by Little, Scitovsky and Scott [1] can only be challenged on the basis of genuinely dynamic arguments, and one starting point for these must be an explanation of why productivity growth rates and technical change differ between economies. These issues are at the core of the engine-of-growth hypothesis, and although much remains to be done to substantiate this hypothesis more fully, it is the contention of the author that it provides one of the most useful bases for a challenge to the free trade position.

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*For the period 1965-1973, the result of a cross-sectional analysis over 12 manufacturing branches (t-ratios in parentheses) was:

$$m_{Mex} - m_{US} = \underset{}{42.20} + \underset{(2.49)}{1.67}(p_{Mex} - p_{comp}) - \underset{(-8.97)}{8.68}s_{Mex}$$

$$R^2 = 0.88; \; n = 12$$

where m_{Mex} and m_{US} are the growth rates of United States imports from Mexico and total United States imports in each branch (1965-1973) respectively,

p_{Mex} and p_{comp} are the growth rates of Mexican and competitors' productivity in each branch respectively, and

s_{Mex} is the initial (1965) share of Mexican imports in total United States imports in each branch.

All growth rates are in natural logarithms.

For the period 1973-1978, relative productivity growth was a weaker explanatory variable, significant only at the 90 per cent level and with a low value of R^2:

$$m_{Mex} - m_{US} = \underset{}{5.94} + \underset{(2.02)}{1.51}\,(p_{Mex} - p_{comp})$$

$$R^2 = 0.29; \; n = 12$$

Data for the analyses were compiled at the Ministry of Industry and Natural Resources, Mexico City.

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TECHNOLOGICAL INNOVATION AND SOCIAL COST BENEFIT ANALYSIS IN DEVELOPING COUNTRIES

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Background

The role of technological innovation in economic growth has long been accepted in the context of industrialized economies. For example, the 1920s hypotheses of Kondratieff concerning long-wave technological cycles are now being invoked to explain the world recession in terms of the "rationalizing down-swing" of the age of electronics. For developing countries, however, the interest in the part played by technology has, until fairly recently, been concerned not so much with domestic innovation processes but rather restricted to the conditions under which technology should be transferred from industrialized countries and how it should be selected from whatever "menu" is available. This has involved the analysis of transfer mechanisms, technology cost and regulation, the choice of technique and domestic technology development policy within the assumed context of technological dependence (e.g., Cooper [1, 2] and Vaitsos [3]).

Over the past few years, however, following case studies of technical innovation in, for example, Brazil, the Republic of Korea and the Taiwan Province of China, it has been shown that significant product and process innovation has occurred on the periphery, contrary, it would appear, to the predictions of the dependency model of the late 1960s and early 1970s. There is some controversy about the political-economic nature of these developments and their implications for technological "catching-up" (Frank [4] and Kaplinsky [5]). Leaving this aside, however, to the extent that domestic innovation is a feasible option in Brazil, the Republic of Korea and the Taiwan Province, it follows that economic planning may need to incorporate innovation effects. Planning for innovation has not been carried out in any detail in developing countries but only in the general terms of perspective planning, for example in India. The present paper is concerned with the rationale and practicality of taking account of innovation effects within a particular planning technique - social cost benefit analysis. It is an attempt to conceptualize conditions under which process innovation may be predictable at the project level.

Social cost benefit analysis: some issues

Over the 30 years or so since it was formally introduced into planning methodology, social cost benefit analysis (SCBA) has probably received a disproportionately high input of academic and professional effort in its development and application and a corresponding amount of criticism, sometimes bordering on hysteria. The reason for this is that SCBA appears to offer simple (or, for some, simplistic or erroneous) answers to complex questions about investment and economic development. The fact that the technique has survived and apparently extended its influence may be because, in the end, it is theoretically (and practically) justified

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