Working Paper

Technological Gaps, Specialization and Growth: A Structuralist/Evolutionary View

Mario Cimoli

WP-94-82
September 1994

IIASA International Institute for Applied Systems Analysis □ A-2361 Laxenburg □ Austria
Telephone: +43 2236 71521 □ Telex: 079 137 iiasa a □ Telefax: +43 2236 71313

Technological Gaps, Specialization and Growth: A Structuralist/Evolutionary View

Mario Cimoli

Dipartimento di Scienze Economiche, Universitá degli Studi di Venezia

WP-94-82
September 1994

The research leading to this work has benefitted at various stages from the support by MURST 40% (progetto "Istituzioni, crescita e sviluppo economico", 1991–92). The paper was written as background material for the seminar on evolutionary modeling within the *Technological and Economic Dynamics Project* at IIASA.

IIASA International Institute for Applied Systems Analysis □ A-2361 Laxenburg □ Austria
Telephone: +43 2236 71521 □ Telex: 079 137 iiasa a □ Telefax: +43 2236 71313

Preface

The research project on *Systems Analysis of Technological and Economic Dynamics* at IIASA is concerned with modeling technological and organisational change; the broader economic developments that are associated with technological change, both as cause and effect; the processes by which economic agents – first of all, business firms – acquire and develop the capabilities to generate, imitate and adopt technological and organisational innovations; and the aggregate dynamics – at the levels of single industries and whole economies – engendered by the interactions among agents which are heterogeneous in their innovative abilities, behavioural rules and expectations. The central purpose is to develop stronger theory and better modeling techniques. However, the basic philosophy is that such theoretical and modeling work is most fruitful when attention is paid to the known empirical details of the phenomena the work aims to address: therefore, a considerable effort is put into a better understanding of the 'stylized facts' concerning corporate organisation routines and strategy; industrial evolution and the 'demography' of firms; patterns of macroeconomic growth and trade.

From a modeling perspective, over the last decade considerable progress has been made on various techniques of dynamic modeling. Some of this work has employed ordinary differential and difference equations, and some of it stochastic equations. A number of efforts have taken advantage of the growing power of simulation techniques. Others have employed more traditional mathematics. As a result of this theoretical work, the toolkit for modeling technological and economic dynamics is significantly richer than it was a decade ago.

During the same period, there have been major advances in the empirical understanding. There are now many more detailed technological histories available. Much more is known about the similarities and differences of technical advance in different fields and industries and there is some understanding of the key variables that lie behind those differences. A number of studies have provided rich information about how industry structure co-evolves with technology. In addition to empirical work at the technology or sector level, the last decade has also seen a great deal of empirical research on productivity growth and measured technical advance at the level of whole economies. A considerable body of empirical research now exists on the facts that seem associated with different rates of productivity growth across the range of nations, with the dynamics of convergence and divergence in the levels and rates of growth of income, with the diverse national institutional arrangements in which technological change is embedded.

As a result of this recent empirical work, the questions that successful theory and useful modeling techniques ought to address now are much more clearly defined. The theoretical work has often been undertaken in appreciation of certain stylized facts that needed to be explained. The list of these 'facts' is indeed very long, ranging from the microeconomic evidence concerning for example dynamic increasing returns in learning activities or the persistence of particular sets of problem-solving routines within business firms; the industry-level evidence on entry, exit and size-distributions – approximately log-normal – all the way to the evidence regarding the time-series properties of major economic aggregates. However, the connection between the theoretical work and the empirical phenomena has so far not been very close. The philosophy of this project is that the chances of developing powerful new theory and useful new analytical techniques can be greatly enhanced by performing the work in an environment where scholars who understand the empirical phenomena provide questions and challenges for the theorists and their work.

In particular, the project is meant to pursue an 'evolutionary' interpretation of technological and economic dynamics modeling, first, the processes by which individual agents and organisations learn, search, adapt; second, the economic analogues of 'natural selection' by which interactive environments – often markets – winnow out a population whose members have different attributes and behavioural traits; and, third, the collective emergence of statistical patterns, regularities and higher-level structures as the aggregate outcomes of the two former processes.

Together with a group of researchers located permanently at IIASA, the project coordinates multiple research efforts undertaken in several institutions around the world, organises workshops and provides a venue of scientific discussion among scholars working on evolutionary modeling, computer simulation and non-linear dynamical systems.

The research focuses upon the following three major areas:

1. Learning Processes and Organisational Competence.

2. Technological and Industrial Dynamics

3. Innovation, Competition and Macrodynamics

Introduction

Since the 1960's, the central purpose of most contributions in the field of technology and trade has been to highlight the crucial importance of technological change and innovation in explaining international trade pattern; e.g. Posner (1961), Freeman (1963) (1965), Hirsch (1965), Hufbauer (1966) and Vernon (1966).

This approach has stressed international *asymmetries in technology* as the main determinant of the trade flows and the patterns of specialisation. Technology is characterised as a good that is not free and that gives an important advantage to the first innovator country. Moreover, in a dynamic context, the asymmetries in technological levels and innovative capabilities mainly explain the evolution in the pattern of specialisation and the growth capabilities of each country. In Posner (1961), the pattern of trade is explained by the initial asymmetric access to technological knowledge in a world characterised by similarities in demand patterns. In this context, the trade between countries will be maintained if the differences in national abilities to innovate and imitate persist. After a time lapse, most countries can imitate the new commodity and restore technological parity, eliminating also the basis for trade. Freeman (1963) and Hufbauer (1966) have stressed the differences in the factors which determine the specialisation before and after the imitation process takes place. Thus, during the innovation process the effects of patents, commercial secrecy, static and dynamic economies of scale prevail. However, once imitation occurs, the specialisation will be determined by the traditional process of adjustment in production cost and competitiveness.

In Hirsch (1965) and Vernon (1966), the technological asymmetries are associated with distinct phases in the evolution of a technology and a specific international distribution of innovative capabilities in the production of new commodities. For the initial phase, innovative advantage is the main feature, explaining the production of new commodities in the advanced countries. Over time, the technology evolves into a mature phase, characterised by the standardisation of products and processes. In this latter phase, international competition is based on production cost advantages and the technology can be transferred to the less developed economies, whose comparative advantage lies in their lower real wages. In this respect, the pattern of trade is considered a process of *technological divergence and convergence*, for which the innovative process induces divergence while imitation and diffusion induce convergence between countries.

In so doing many of these studies have undoubtedly scored points with policy makers who have increasingly come to recognise the significance of technology for international competitiveness. The theoretical basis of these contributions remains however poor. This is in fact not surprising. The introduction of "technology" in any kind of trade model, whether of the classical or neo-classical sort, raises many challenges. The complexity of the phenomenon of technological change on the one hand (with its dual impact on efficiency and new demand) and the essential dynamic "change" perspective implicit in the concept of technological change on the other, are difficult to handle in their globality in any kind of economic model.

The recent "structuralist/evolutionary" formal approach show increasing attention to uneven international technological change as an engine of growth with emphasis on the *dynamics of specialisation* as in Metcalfe (1989), Amable (1992), (1993), Boggio (1993) and Soete and Verspagen (1992) and, on the *dynamics of catching-up* as analysed in Verspagen (1990), (1991) and Dosi and Freeman (1992).

In this context, the formal approach developed in Dosi and Soete (1983), Cimoli (1988), (1991), Dosi, Pavitt and Soete (1990), Canter and Hanusch (1990) and Cimoli and Soete (1992) has pinpointed the importance of the interplay between absolute and comparative advantages as determinants of the participation of each country in world trade, the dominance of technological gaps in the process of international specialisation, and the bounds imposed by the dynamics of innovation and trade on the "growth possibility sets" of each economy.

On the determinants of absolute and comparative advantages, technological gaps -in terms of product and process innovation- and institutional asymmetries - in terms of the main form of organisation of labour markets- contribute to determining the pattern of specialisation and its evolution over time. On the demand side, on the other hand, the asymmetries in the national consumption patterns, which regard the price and income elasticities, play a crucial role for the interplay between specialisation and macroeconomic level of activity. Finally, the trade balance condition determines the growth rate differential of trading economies, as has emerged in the well-known Kaldorian export-base models (Kaldor (1966),(1975), Kennedy and Thirlwall (1979), Thirlwall (1980), Dixon and Thirlwall (1975)).

The main characteristics of this approach can be viewed not only in terms of modelling methodologies, but also in the ways in which some of the empirical properties of the world economy are considered. Thus, the structuralist/evolutionary approach has tried to account for what can be reasonably considered as some fundamental properties affecting the interplay between trade and growth: a) the different commodities show a wide range of price and income elasticities; b) the rate of growth of each economy is normally constrained by the need to balance the foreign account; c) wage rates are mainly determined by institutional factors which account for the mechanism that relates wage and productivity over time; and d) the interplay between technical change, trade, and growth has to be interpreted as a mechanism that generates a tendency to converge to an equilibrium in the world rate of growth only as a particular case.

In *Part I*, building on these ideas we shall demonstrate here that the growth of the relative trading partners depends not only on the demand structure of each economy constrained by the balance of payment conditions, but also on differences in technology. Furthermore, the technological gap will be introduced as one of the main variables explaining the pattern of growth possibilities through the effect of what we will refer to here as the *technological gap multiplier*. In a sense, this concept can be considered a new element for the definition of a larger *taxonomy* of trade interdependencies from which one can also obtain the standard results of the traditional approaches to balance of payments constrained growth as a sequence of particular cases. We shall also demonstrate that the traditional results associated to the multiplier mechanism in the determination of Keynesian levels of activity in open economies, the elasticity and the absorption approaches to the balance of payments and the Harrod-Kaldor foreign trade multiplier are valid only for the particular case of a fixed pattern of specialisation or small technological gap multiplier. The model developed here is from this perspective fully generalizable, i.e. to explain trade between countries with different technological gaps (North-North, North-South or South-South).

In *Part II*, we shall adapt the model to the analysis of the endogenous evolution of the pattern of trade. The dynamics of the national productivity levels and comparative (dis)advantages will be determined by a law of dynamics of increasing returns and a cumulative learning mechanism[1]. The dynamics of specialisation for the commodities produced in the home and foreign economies are explained by the differences in technological capabilities -approximated by the technological multiplier- and the evolution of wages and productivity levels over time.

On the grounds of this context, we shall emphasise the interplay that exists between the dynamic endogenous changes of comparative advantages, specialisations, and the national consumption patterns for the determination of

[1] In Cimoli (1991) the dynamics of comparative (dis)advantages is determined by the shares of the home and foreign commodities prduced in the world economy; a similar dynamic approach in a more marked evolutionary context is developed in Metcalfe (1989).

growth possibilities. The national consumption patterns are determined by a mix average of income and price elasticities for a pattern of endogenously-determined specialisation. Thus, the sectoral distribution of specialisation can determine a divergence between the production and consumption pattern at the national level. In this context, as introduced in Pasinetti (1981), the asymmetry in domestic and foreign consumption pattern is considered as a key element in the explanation of the convergence vs. divergence in the output rate of growth.

A stable pattern of specialisation or its dynamics can give rise to a consumption pattern that interacts in the determination of a process of convergence or divergence in the output rate of growth. In this context, we shall demonstrate that a balanced growth path exists, but this is a particular case among different scenarios dominated by forging-ahead and falling-behind perspectives.

Part I

I) The pattern of specialisation and technological gaps

The model presented here is based on Cimoli (1988), Dosi, Pavitt and Soete (1990) and Cimoli and Soete (1992) which has been further analysed in the empirical studies developed in Soete and Verspagen (1992) and Beelen and Verspagen (1993)[2]. We shall consider the technological capabilities of trading partners in the production of two sorts of commodities: *Ricardian and Innovative commodities*. In our model the technological asymmetries between countries will be related to both comparative and absolute advantages, leaving aside the issue about the dominance of one over the other. Technological "gaps" can then be related to absolute advantages (for instance in terms of product innovations) and comparative advantages (for instance in terms of process innovations approximated by differences in unit labour costs, productivity and wages). Other asymmetries related to the demand structure and labour market will however also be considered and determine jointly with the differences in technology the process of international specialisation and the delimitation of the growth possibility "set" for each country. In other words, we shall be considering a highly stylised model whose purpose it is to account jointly for the impact of these asymmetries and the balance of payment constraint upon the growth possibility of each economy.

The main characteristics and assumptions of the model are the following:

1) there are two countries, a home and foreign country, producing n commodities and using one factor of production. In other words we will consider a highly stylised $2 \times n \times 1$ model;

2) there are two sorts of commodities: Ricardian (or standardised) and innovative ones;

3) the Ricardian commodities can be produced and exported by both countries, the innovative commodities only by the foreign country. In other words, it is the home country which can be considered as the technologically backward one;

4) markets are not assumed to clear. In particular in the case of the labour market, wages can be considered as being exogenously determined and related to institutional factors in each country;

---

2 See, Dornbusch, Fischer and Samuelson (1977), Wilson (1980), and Collins (1985), on a continuum of goods.

5) it is assumed that each country faces a different import demand structure associated mainly to the income and price elasticity for each commodity: i.e. we do not assume homotheticity of the demand function.

We start with the idea of a continuum of goods which can be ordered by a real index on an interval $[o,z_1]$, where z_1 is the number of commodities produced in the world economy. A continuum of goods implies that each good corresponds to a real number on the interval. We propose to order the set of commodities in terms of the increasing *technological intensity* of each commodity, from 0 to z_1.As many empirical studies[3] in the trade and technology area have shown, the assumption that product can be ranked by some proxy of technological intensity, to a large extent irrespective of the particular country, is very much supported by the available empirical evidence.

Technology intensity can, in other words, be translated into empirical terms in a relatively straightforward manner; e.g. expenditures (direct and indirect) on R&D (David 1988), the number of patents granted Pavitt and Patel (1988) or the quality index of economic activities and the historical evolution of traditional and innovative commodities (Reinert (1993)). In the model which follows, we will assume that the technological intensity of the commodities is monotonically related to the technological gap between the two trading partners: i.e. the difference in production efficiency in the two regions grows monotonically with the technological complexity, difficulty of imitation and lack of appropriate skills for the production of the commodities[4] .

We can now analyse the process of the introduction and imitation of new commodities. The technology gap and product life cycle approaches have emphasised the fact that the introduction of new products is not uniform across countries. This international difference in the capability of developing product innovations is an important feature of the pattern of trade. In our model, we will assume that most of the new products are introduced by the foreign country, and only later by the home country once it has learnt (and/or imitated) how to produce these goods. In order to introduce the innovation commodities into the pattern of trade the range of commodities $[o,z_1]$ must be rearranged. The range of commodities is divided into two distinguishable sets: $[o,z_0]$ and $[z_0,z_1]$, where $z_1>z_0$. In the first set the established, "old" commodities are ranked; z_0 is the number of old commodities produced in the world economy. These commodities, which we will call *Ricardian commodities*, are characterised by a lower

[3] For an overview see Soete (1987) and Dosi, Soete and Pavitt (1990).

[4] This is of course a theoretical abstraction; one can cite plenty of empirical examples of high technology goods quickly imitated and efficiently produced by less developed countries. However, as a general assumption, it does not do too great a violence to historical evidence.

technological intensity than the innovative commodities, and can be produced by the home and foreign countries. The second set orders the innovative commodities which can only be produced by the foreign country.

At any given point in time there will be a notional equilibrium distribution within the whole product range between Ricardian and innovative commodities which is given. We develop the model below by assuming a given z_1 and z_0. The whole set of commodities will be distributed over the innovative and Ricardian sets, as shown in figure 1. It will be clear that this is only an analytical device which will help us in exploring the properties of the system: as a matter of fact the process of technological change will continuously increase the whole range of commodities over time.

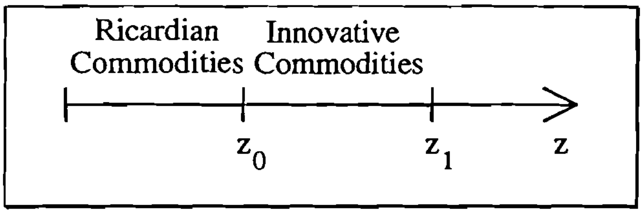

Figure 1

Let us now define the group of Ricardian commodities and the specialisation criteria associated with them. These commodities are produced and exported either by the home or the foreign country according to the relative production costs (denominated in a common unit), which are explained by the technological gap. By technological gap in Ricardian commodities we mean the unequivocal difference between the home and foreign country in input efficiency; i.e. the superiority/inferiority of the input efficiencies independent of relative prices. The production of these commodities in one region or another depends in other words on the differences in, for example, labour and capital input efficiencies. These differences can be applied to cases where the techniques of production - in terms of quality and type of machinery employed, etc. - are similar and/or different. The specialisation pattern sets can thus be specified in terms of our definition of the technological gap in Ricardian commodities, in the first instance differences in labour productivities.

To begin with and for the sake of simplicity, let us assume that labour is the only factor of production. The level of wages is related to the specific labour market features of each country's economy. Profits are zero in both regions. The Ricardian commodities can now be indexed on the interval $[o,z_0]$ of our continuum of goods, where z represents one particular commodity associated with a point on the interval. These commodities can be produced in the home and the foreign countries, the constant labour input coefficients are denoted by $a^*(z)$ for the home country and a_1 for the foreign country for each commodity; thus, the Ricardian commodities are ranked on a continuum according to the relative input coefficients in both countries. In others words, on this interval, we can superimpose the ordering related to the home-foreign relative labour input efficiencies.

Moreover, it can now be assumed that the home economy is more efficient in the production of the commodities with low levels of technological intensity, whereas foreign relative efficiency is higher for the commodities nearer to the innovation interval. With regard to the Ricardian commodities, we may thus define the following function: $A(z)=a^*(z)/a(z)$, where $A'(z)>0$[5]. Thus, the function A( ) ranks the Ricardian commodities in terms of an increasing foreign-home technological gap.

Within the range $[o,z_0]$, international specialisation will take place in the foreign or home country depending on wherever it is cheaper to produce at current wages and labour productivities. Let w^* and w denote the home and foreign wages, so that any commodity z will be produced in the foreign country when $a(z)w \leq a^*(z)w^*$.This inequality with an equality sign defines the borderline commodity $\tilde{z}$, which can be written as the following function: $\tilde{z}=A^{-1}(W)$ where $W=w/w^*$ denotes relative wages and $A^{-1}(\ )$ the inverse function of A( ). The process of specialisation is shown in figure 2. For a given relative wage W, the home country is specialised in the set of commodities $[o,\tilde{z}]$, and the foreign country in the set $[\tilde{z},z_1]$. An increase in the foreign wage relative to the domestic wage reduces the set of commodities that the foreign country can competitively produce, and vice versa. The effect of any given change in the relative wage on the borderline commodity $\tilde{z}$ is related to the slope of the A( ) function[6].

---

[5] Note that the domain of the function A( ) is [o,z], which is assumed to be differentiable and invertible. We can also note an important point about the assumed *unit labour requirement function A( )*: this ensures that the goods are ordered by an increasing comparative advantage of the foreign country relative to the home country. With both Labour and Capital inputs, and assuming the labour force is homogenous - in terms of capabilities to use different and similar machinery - in the home and foreign countries the commodities are ranked in terms of the increasing capital input efficiencies. The results obtained from this simplified model also apply in those cases where there are capital inputs and positive profits when there is no "reswitching of commodities". See Dosi, Pavitt and Soete (1990).

[6] Within this framework we can note two extreme cases of possibility of "non specialization", i.e., when A( ) is vertical or horizontal the specialization is indeterminate. In the latter case when A( )=1, the labour productivities in both regions are identical for each commodity and consequently there are no technological differences between both countries.

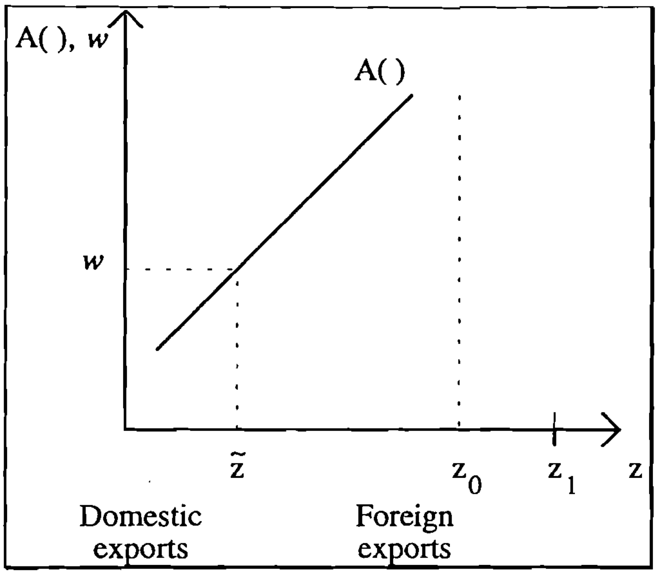

Figure 2

Following the technological-gap definition discussed earlier, on the slope of the A( ) function gives us a representation of the domestic (and/or foreign) relative efficiency in the production of Ricardian commodities. The pattern of specialisation for a given A( ) function (and thus also for a given technology gap) is determined by relative wages. Insofar as a change in the borderline $\tilde{z}$ is a function of the change in relative wages, we can write:

(1)

$$\psi = \frac{W}{\tilde{z}} \frac{\partial \tilde{z}}{\partial W} = \frac{1}{\psi^{A\tilde{z}}}$$

we shall call ψ the *technological gap multiplier*, where $\psi^{AZ} = z/A\ \partial A/\partial z$[7]. The technological gap multiplier approximates the sensitivity of the pattern of specialisation to the changes in relative wages for a given A( ) function. Thus for a large ψ, an increase in relative wages will considerably increase the amount of the commodities domestically exported; when ψ is small an increase in W implies a small change in specialisation. Changes in relative wages thus have a significant effect on the share of commodities produced only when the technological gap multiplier is large. For an increasing (decreasing) technology gap in Ricardian

[7] The parameter ψ^{AZ} may be interpreted as the elasticity of the comparative advantage ratio with respect to the index z or the elasticity of the technological gap with respect to Ricardian commodities. A larger (smaller) ψ^{AZ} implies a steeper (flatter) A( ) function which is associated with a large (small) variation in the technology gap. When the technology gap is large in several commodities, domestic relative efficiency will decrease considerably with the increase in the number of commodities produced and exported. In other words, the domestic economy is confronted with a large technology gap when an increase in z is associated with a large increase of foreign relative efficiency

commodities, changes in relative wages produce a small (large) change in the specialisation.

Another pattern of specialisation emerges when the foreign country produces and exports only the innovative commodities and the domestic country all of the Ricardian commodities, i.e. $\tilde{z}=z_0$. Figure 2 shows that in this case an increase in relative wages will not have any effect on the pattern of specialisation, which is solely explained by the relative innovation and imitation capabilities related to product innovations in each country. The pattern of specialisation assumed in Krugman and Dollar's model can thus be considered as a particular case of our model[8]. In this case the model assumes a given pattern of specialisation and the relative growth between countries will be related mainly to the differences in the demand structure and the length of the Ricardian and innovative commodity sets.

II) Specialisation, the structure of demand and the balance of payments constraint

In the analysis which follows, we shall now investigate how the asymmetrical effect of demand can be integrated into the model presented in the previous section.

Let us start with the specification of the demand functions. We have chosen to specify the domestic and foreign demands for imports, since in our model that is what counts in determining the balance of trade equilibrium condition. In the first instance we are interested in per capita demand. This will make it easier to relate the analysis with the levels of employment in both regions.

The demand for a commodity z can be expressed as follows:

$$\beta^*(z) = \frac{p(z)m^*(z, w^*, p(z))}{w^*} \tag{2}$$

$$\beta(z) = \frac{p^*(z)m(z, w\ , p^*(z))}{w} \tag{3}$$

where:

$\beta^*(z)$ and $\beta(z)$ represent per capita domestic and foreign import expenditure shares;

[8] See Krugman (1979) and Dollar (1986).

$m^*(z)$ and $m(z)$ the per capita domestic and foreign demands for imports; and

$p^*(z)$ and $p(z)$ the domestic and foreign prices of commodity z. The demand function that emerges from equations (2) and (3) can be different for each commodity z and the import expenditure shares will not be constant. Consequently, as prices and wages change the domestic and foreign expenditure shares will also change depending on the income and price elasticities of the commodities imported into each country.

Dornbusch, Fisher and Samuelson (1977), proceeded to close the model by assuming strong homotheticity of the demand function; Wilson (1980) extended this model with respect to the demand structure and the number of countries. Both models have been closed by requiring the labour market to clear. In this respect, our model is radically different. We consider fundamental the differences between countries in the structure of demand and the institutional arrangements in the labour market, which in our view will be more generally of a non-clearing nature rather than vice versa. More precisely, we will try to account for: (a) the large range in price and income elasticities of the different commodities represented by the continuum of goods; and b) the determination of real wages as a result of the forms of organisation and the norms of adjustment which prevail in the home and foreign country. By bringing these hypotheses into the picture we will be able to bring together the technological differences, the pattern of specialisation and the labour market specificities of each country.

It will be clear that the latter assumption will allow for the possibility of introducing asymmetries in income and prices elasticities between domestic and foreign import demand, so that the model can reproduce the usual result of growth models with balance of payments constraints.

Assuming that $0<\tilde{z}<z_0$, which defines a pattern of specialisation between the home and the foreign country, we can write:

(4)

$$\Gamma(\beta,\tilde{z}) = \int_0^{\tilde{z}} \beta(z)dz$$

(5)

$$\Gamma^*(\beta^*,z_1) = \int_{\tilde{z}}^{z_1} \beta^*(z)dz$$

where,

Γ^* is the share of the wage in the home country spent on the innovation and Ricardian commodities produced in the foreign country; and

Γ is the share of the wage in the foreign country spent on the Ricardian commodities produced in the home country.

To get an expression of the balance of trade equilibrium condition we must now specify total domestic imports and exports. These can be expressed as[9] :

$$M^* = Y^*\Gamma^*(\beta^*, \tilde{z}, z_1) \tag{6}$$

$$X^* = Y\Gamma(\beta, \tilde{z}) \tag{7}$$

where M^* is the total import demand in the home country, X^* is the home export (i.e. the import demand in the foreign country), Y^* and Y are the home and foreign incomes in which wages are the only component. Then the trade equilibrium condition is:

$$Y^*\Gamma^* = Y\Gamma \tag{8}$$

Rearranging (8) and substituting for β^* and β, we obtain

$$\psi = \frac{Y^*}{Y} = \frac{\int_0^{\tilde{z}} \beta(z)dz}{\int_{\tilde{z}}^{z_1} \beta^*(z)dz} \quad \text{or} \quad Y^* = \frac{\Gamma(\beta, \tilde{z})}{\Gamma^*(\beta^*, \tilde{z}, z_1)} Y \tag{9}$$

The domestic relative income ψ depends on: (a) relative wages, which have itself an impact on relative prices, the demand for the commodities domestically imported and exported, and the pattern of specialisation; (b) differences in the parameters that define the demand structures; and (c) the technological gaps that together with wages determine the limit of integration $\tilde{z}$.

Equation (9) tells us that the domestic relative income which ensures the open-economy macroeconomic equilibrium is a function of the foreign and domestic shares spent on imported commodities. It is clear that Γ^* and Γ can also be interpreted as the import propensities in the home and foreign country, respectively. In this sense, equation (9) can be taken as a static formalisation of Harrod's foreign trade multiplier, as revived by Kaldor and Thirlwall[10].

---

[9] The model will be considered under the conditions of $0<\Gamma<1$ and $0<\Gamma^*<1$. In the two extreme cases when $\Gamma=0$ $\Gamma^*=0$ and $\Gamma=1$ $\Gamma^*=1$ we have either no trade or 'total' trade (i.e. everything which is produced is exported) between the two countries.

[10] As in Kaldor (1975), Kennedy and Thirlwall (1979), Thirlwall (1979), (1980), Thirlwall and Dixon (1979), Thirlwall and Hussain (1982).

Our approach is however significantly different from the latter since we are also allowing for the possibility of changes in the pattern of trade. That is, changes in the domestic relative income are not only a function of foreign income and the demand for imports, but are also dependent on changes in the pattern of specialisation. In this respect, the changes in the real wage affect the demand for imports, the impact of which is weighted by the price and income elasticities of each commodity, and the range of commodities produced and exported by both countries. The impact of the latter effect is itself determined by the relative differences in the input labour efficiencies in the production of Ricardian commodities, defined as the technological gap. By introducing the possibility of changes in the pattern of specialisation, we will be able to link the technological gap and differences in the demand structure, which will explain simultaneously the domestic growth possibilities.

Let us now summarise the implications of our model so far.

First, the model allows us to link the pattern of specialisation with differences in the demand structure between the two countries. Technological gaps determine the set of possible patterns of specialisation and the asymmetry in demand determines the different effects on the quantities produced and exported of each commodity. From this picture, we will now be able to provide a link between the conditions which determine the pattern of specialisation and a "Keynesian" determination of the levels of activity.

Second, it is important to stress the difference between our present model and the standard approach to growth based on the balance of payment constraint. In the latter the pattern of specialisation is given, and the only factor that affects relative income is the difference between the two countries in the demand for imports and growth rates. In our model the quantity of different commodities that each country produces - determined by the specialisation pattern - and the demand effect - that determines the quantity of each commodity produced - are simultaneous factors in the determination of relative income.

III) <u>Technical progress and the technological multiplier with a balance of payment constrained growth</u>

In this last section, we shall put forward the dynamic extension of the model. We begin by analysing the effect of uniform technical progress on relative efficiencies in the production of Ricardian commodities in the two countries. Technological change does not only lead to the introduction of new commodities, it will also be a crucial factor for the efficiency with which existing products are being produced. In other words, the innovative and imitative capabilities in the two countries will be used in the development of both new products and the improvement of production processes. In the latter case, technological progress will be defined by the reduction in the unit labour requirements for the production of Ricardian commodities. All *process innovations* will increase labour productivity in the foreign country and its relative efficiency. Conversely, all *process imitation* will increase domestic relative efficiency in the production of Ricardian commodities. In other words, process innovations induce divergence whereas process imitations induce convergence of the productivity levels between countries.

The increase of labour productivities in the two countries depends thus on the innovation and imitation capabilities as they are translated into the production of Ricardian commodities in the foreign and home country respectively. Under the assumption of uniform technical progress across commodities in both economies, the per cent change in the labour required to produce domestically a unit of good z, $\dot{a}^*$, or abroad, $\dot{a}$, can be expressed as:

$$\dot{a}^* = \xi^* g \tag{10}$$

$$\dot{a} = \xi i \tag{11}$$

where g is the domestic rate of imitation and i the foreign innovation rate. Uniform technical progress implies that $-1 \leq \xi^* < 0$ and $-1 < \xi < 0$, where ξ^* and ξ can be interpreted as the translation of the imitative and innovative capabilities in the production of Ricardian commodities. If $\xi^* = \xi = -1$, the innovative and imitative capabilities developed in the production of new commodities are fully used in the production process. It is clear that the differences in productivity growth will depend on ξ^*, ξ and the innovative and imitative rates.

As illustrated in figure 3, uniform technical progress in the home country (or a uniform reduction of unit labour requirements) will shift the schedule A^0A^0 downwards, thus allowing for a given relative wage ratio a wider specialisation pattern with a gain of some products. The opposite applies in the case of a uniform reduction of the unit labour requirements in the foreign country. Two extreme cases are illustrated in figure 3. For example when $\xi = 0$ e.g. (technical progress takes only place domestically), the schedule A^0A^0 in figure 3 would shift downwards to A"A".

For $\xi^*=0$, a uniform reduction of unit labour requirements in the foreign country would shift the schedule A^0A^0 upward to A'A'.

The model accounts thus for the general divergent and convergent technology gap patterns: an increase in innovative capabilities in the foreign country - related to more efficient production methods - implies divergence in technological gaps; an increase in imitative capabilities in the home country convergence. Under the hypothesis of uniform technical progress the changes over time in $\tilde{z}$ can be expressed as:

$$\dot{\tilde{z}} = \psi\left[(\dot{w} - \dot{w}^*) - (\xi i - \xi^* g)\right] \tag{12}$$

As equation (12) illustrates, the changes of $\tilde{z}$ is a function of the per cent change in wages and productivities in both countries. Two important aspects of equation (12) need to be stressed.

First, the change in $\tilde{z}$ gives the adjustment in the pattern of specialisation among Ricardian commodities, which captures mainly the sensitivity of the system to changes in relative wages and productivities (the relative unit labour cost in both economies). Thus, the (imitative) home country willing to increase its wage at the same rate as the (innovative) foreign country without losing competitiveness in the production of Ricardian commodities has to sustain a rate of imitation in production processes (productivity improvements) equal to the rate of innovation of the foreign country. The home country may catch up if its rate of productivity is higher than in the foreign country. Conversely, a smaller rate of imitation (or rate of productivity growth) implies a reduction in the range of commodities produced domestically; the pattern of specialisation moves in favour of the foreign country increasing its relative efficiency in the production of Ricardian commodities.

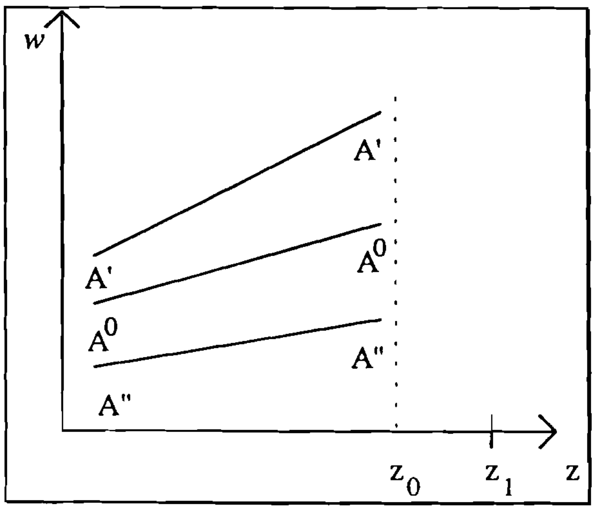

Figure 3

Second, the significance of the multiplicative form that assumes the differences in technology between the two countries ($\psi = 1/\psi^{A\bar{Z}}$). The changes in the pattern of specialisation are weighted by the *technological gap multiplier*, which accounts for the initial distance in productivity levels between the two countries. There is thus a limit to how wages and productivity improvements can induce changes in specialisation when the existing technological gap is already high (think, for example, of the case of trade between less developed and industrialised countries). Conversely, in case of a small technological gap, adjustments in the pattern of specialisation will be very sensitive to changes in wages and productivities (think, for example, of trade between industrialised countries).

The different possible impacts on changes in the pattern of specialisation are summarised in table 1.

	$w=w^*$	$w>w^*$	$w<w^*$
$\xi^* g = \xi i$	0	+	-
$\xi^* g > \xi i$	+	+	+ o -
$\xi^* g < \xi i$	-	+ o -	-

Table 1*

* where: + stands for "in favour of domestic country", and - stands for "in favour of foreign country".

Decomposing equation (12) we have:

$$\dot{\theta}_w = (\dot{w} - \dot{w}^*) \tag{13}$$

$$\dot{\theta}_h = (\xi i - \xi^* g) \tag{14}$$

where $\dot{\theta}_w$ can be interpreted as the weighted per cent change in relative wages and $\dot{\theta}_h$ as the difference in productivity changes in the two countries, and $\dot{\theta}_\tau = (\dot{\theta}_w - \dot{\theta}_h)$.

In order to get an expression for the domestic relative income growth, we need now to specify the per cent change in the share spent on imports. Let $\dot{\beta}^*(z)$ and $\dot{\beta}(z)$ denote the per cent changes in the domestic and foreign shares spent on the import of commodity z, so that:

$$\dot{\beta}^*(z) = \frac{1}{\beta^*}\frac{d\beta^*}{dt} = \dot{w}^*(\varepsilon^*(z) - 1) + \dot{p}(z)(1 - \eta^*(z)) \tag{15}$$

Table 2

A Taxonomy of Trade Interdependence in a Technological Gap Model

Import demand effect	Factoral terms of trade effect	Technological and specialisation effect	Domestic relative rate of growth
$\dot{w}>\dot{w}^*$	$\dot{p}>\dot{p}^*$	depends on Technological gap multiplier	
$\varepsilon=\varepsilon^*=1$	$\eta>1,\eta^*<1$	a) small Ψ b) large Ψ	a) decrease b) depends on which effect prevails
	$\eta<1,\eta^*>1$	c) small or large Ψ	c) increase
$\dot{w}>\dot{w}^*$	$\dot{p}>\dot{p}^*$	depends on Technological gap multiplier	
$\varepsilon>1,\varepsilon^*<1$	$\eta=\eta^*=1$	small or large Ψ	increase
$\varepsilon<1,\varepsilon^*>1$		a) small Ψ b) large Ψ	a) decrease b) depends on which effect prevails
$\dot{w}>\dot{w}^*$	$\dot{p}>\dot{p}^*$	faster increase of Domestic productivity $\dot{\theta}_\tau>0$	depends on which effect prevails and elasticities
$\varepsilon=\varepsilon^*=1$	$\eta=\eta^*=1$	a) small Ψ, $\dot{\theta}_\tau>0$ b) large Ψ, $\dot{\theta}_\tau>0$	increase
$\varepsilon<1,\varepsilon^*>1$	$\eta=\eta^*=1$	a) small Ψ, $\dot{\theta}_\tau>0$ b) large Ψ, $\dot{\theta}_\tau>0$	depends on which effect prevails
$\varepsilon=\varepsilon^*=1$	$\eta<1,\eta^*>1$	a) small Ψ, $\dot{\theta}_\tau<0$ b) large Ψ, $\dot{\theta}_\tau<0$	a) decrease b) depends on which effect prevails
$\varepsilon<1,\varepsilon^*>1$	$\eta<1,\eta^*>1$	small Ψ, $\dot{\theta}_\tau<0$	decrease

(16)

$$\dot{\beta}(z) = \frac{1}{\beta}\frac{d\beta}{dt} = \dot{w}(\varepsilon(z) - 1) + \dot{p}^*(z)(1 - \eta(z))$$

where ε^* and ε are the income elasticities, and η^* and η the price elasticities in the home and foreign country respectively. Equations (15) and (16) capture the demand absorption and price effects; note that the changes in prices can be decomposed as: $\dot{p}=\dot{w}+\dot{a}$ and $\dot{p}^*=\dot{w}^*+\dot{a}^*$.

The demand function for the domestic and foreign imports are assumed to take a multiplicative form with wages and prices as the two components, weighted by the income and price elasticities. The model thus accounts for differences in the demand structure as another determinant of the relative growth between the two countries. The per cent change in the domestic relative income follows then from the following equation:

(17)

$$\dot{y} = \frac{1}{\Gamma}\int_{0}^{\tilde{z}} \beta(z)\dot{\beta}(z)dz - \frac{1}{\Gamma^*}\int_{\tilde{z}}^{z_1} \beta^*(z)\dot{\beta}^*(z)dz + \left[\psi\left(\dot{\theta}_w - \dot{\theta}_h\right)\right]\left(\frac{\beta(\tilde{z})}{\Gamma} + \frac{\beta^*(\tilde{z})}{\Gamma^*}\right)$$

Equation (17) illustrates how the domestic relative rate of growth compatible with the trade balance constraint is a function of: (a) the difference in the demand structure between the two countries (i.e. the income and price elasticities in both economies); (b) the changes in the per capita demand absorption of imported commodities and the changes in relative prices and/or factoral terms of trade (i.e. $\dot{\beta}^*$ and $\dot{\beta}$); and (c) the technological multiplier and the relative changes in the pattern of specialisation (i.e. ψ, $\dot{\theta}_w$ and $\dot{\theta}_h$). The net effect on domestic relative income will depend on how these changes are compensated.

Table 2 indicates a large taxonomy of different cases resulting from this model according to the intensity of technological multiplier; the changes in the specialisation pattern associated to differences in wages and labour productivities; and the changes in the respective import propensities. More precisely, the following general properties of our model can be derived from equations (15), (16) and (17):

(i) As illustrated in the previous section, when the technological gap multiplier is small the pattern of specialisation will remain stable. Thus, the change in domestic income depends on how the deterioration of the terms of trade and the increase in

foreign imports will be compensated. For a technology gap multiplier near zero, the model will tend to reproduce the same conclusion as in the case of complete specialisation; the home country does not benefit from an increase in the wage and/or labour productivity abroad, since the domestic relative income will have deteriorated. A similar case exists when $\tilde{z}=z_0$, i.e. when the foreign country produces only the innovative commodities and the home country the Ricardian ones; domestic relative income will again only be affected through the demand and price changes.

(ii) if the pattern of specialisation remains stable (i.e. ignore the third term on the right hand side of equation 17), and if both countries have a similar demand structure with income elasticities equal to unity and price elasticities less than unity (i.e. ignore the first part on the right hand side of both equations 15 and 16); a faster increase in domestic than foreign prices will lead to a higher domestic relative rate of growth ($\dot{\beta}(z)>\dot{\beta}^*(z)$). Conversely, a deterioration in the domestic factoral terms of trade will be associated with a lower equilibrium growth rate. In this case (and under the additional assumption of constant labour input coefficients) the effects of an increase in domestic relative wages will be identical to an improvement in the domestic factoral terms of trade. An improvement of the domestic terms of trade can however also be associated with a deterioration of domestic relative income when the home country's price elasticities are high (i.e. $\eta^*>1$), i.e. as in the celebrated case of immiserizing growth.

(iii) Under the assumption of (again) a stable pattern of specialisation, a similar demand structure in the two countries but with domestic and foreign price elasticity equal to 1, (ignore this time the second part on the right hand side of both equations 15 and 16), a faster increase in per capita domestic import demand than in the foreign country will lead to a relatively lower domestic rate of growth ($\dot{\beta}^*(z)>\dot{\beta}(z)$). The demand absorption effect will be related to the asymmetry in the domestic and foreign income elasticities; thus for the extreme cases when $\varepsilon^*<1$ and $\varepsilon>1$ the domestic relative rate of growth, as a result of a faster relative per capita income demand could actually be higher. In other words, and as emphasised in much of the trade and development literature, the effect of the asymmetry on import demand is associated to the "type" and the income elasticities of the commodities produced and exported in both countries (one may think here of the case of primary and manufactured commodities or the different income elasticities associated with low and high tech products).

(iv) In so far as changes in wages and productivities have also an impact on the specialisation pattern, most of the effects described above can be neutralised by the changes in the pattern of specialisation, which could move in favour or to

the detriment of the domestic country. What emerges, in other words, is that the traditional income growth effects due to relative changes in prices and wages and differences in the demand structure are not so clear (let alone obvious) once the possibility of changes in the pattern of specialisation are considered. An increase in the home wage will for instance reduce the range of commodities domestically produced and exported and will consequently change the pattern of specialisation in favour of the foreign country. The domestic relative rate of growth will decrease proportionally with the technological gap multiplier. Thus in case of a large technology gap multiplier, a large number of commodities might be lost for the home country. By contrast in case of a small technological gap multiplier, the model will take the form of complete specialisation and changes in the domestic relative income will be primarily explained by the demand structure and price effects.

An increase in the foreign wage, on the other hand, when the technological gap multiplier is small - with consequently little impact on the pattern of specialisation - will affect the domestic rate of growth negatively via the worsening of the terms of trade. If the technological gap multiplier is large, however, the negative effect for the home country on the terms of trade can again be compensated by an increase in the amount of commodities exported by the home country.

The model illustrates for example, that it is particularly in the case of countries with relatively less of a technological gap that the technological gap multiplier will have its most significant effect on the pattern of specialisation, i.e. in the case of North-North or South-South trade, rather than in the extreme stylised North-South case. It is worth noting that the evidence with regard to the dominance of "intra-industry" trade between advanced countries and the importance of product differentiation in such trade flows fits this result neatly.

In the case of a large technological gap on the other hand, it is the reduction of the technological gap which will improve most clearly the domestic relative rate of growth. Here, as in the Krugman model, it is the reduction in the difference in technology with the North which will most directly increase the relative rate of growth of the South.

Looking back at the results obtained in equation (15) and (16) and recalling the definitions introduced in equations (13) and (14), we might consider three particular "stylised" cases. As before all these cases will be under the assumption of asymmetry in import demand, different behaviour in wages but uniform technical change in the two countries.

In the first case, the rate of productivity growth is identical in both countries ($\dot{\theta}_h$ =0); domestic wages do not grow ($\dot{w}^*$=0) and the rate of growth of the foreign wage is given by $\dot{w}=-\xi\ i$. The difference in wage behaviour can be expressed as $\dot{\theta}_w$ >0. Under these assumptions, $\dot{\beta}^*$ will be equal to and $\dot{\beta}$ less than nil. It then follows from equation (17) that domestic relative income will grow, if the change in the specialisation effect prevails over the negative effect of the asymmetry in import demands or, in other words if the technological gap is reduced. If however, as we already mentioned above, the technological gap is very large (i.e. the technological gap multiplier $\psi \cong 0$), domestic income will in any case decrease.

In the second case, we consider that labour productivity growth occurs only in the home country (ξ =0) or $\dot{\theta}_h$<0, whereas wage growth is the same in both areas ($\dot{\theta}_w$ =0). The resulting changes in import demands are again given by $\dot{\beta}^*$=0 and $\dot{\beta}$<0. As in the Prebisch-Singer case, the negative impact on domestic income is represented as a deterioration in its terms of trade. The positive effect, however, is given by the change in the specialisation. If the deterioration in the terms of trade prevails, the net effect will be a diminution of domestic relative income.

In the third case we assume that it is the home country which produces only the Ricardian commodities and the foreign country only the innovative ones ($\tilde{z}$ $=z_0$). The pattern of specialisation is now "fixed" and the changes in wages do not affect the quantity of commodities produced in both countries. The difference in the relative rate of growth is only related to the length of the set of Ricardian versus innovative commodities and the asymmetries in import demand. Growth in domestic relative income will now depend on the imitative and innovative capabilities in the home and foreign country in product innovations as in the stylised case of Krugman (1979) and Dollar (1986).

II Part

I) Comparative (dis)advantages and specialisation

This part is organised as follows. Section *I* reproduces the basic model introduced in the first part on the grounds of the determination of comparative (dis)advantages and patterns of specialisation. Section *II* describes the mechanism that explains the interaction between the Harrod foreign trade and technological gap multipliers. In section *III* we introduce a mechanism that describes the increasing returns and technological cumulative learning. In section *IV* we analyse the endogenous dynamics of comparative (dis)advantages and specialisation. A solution of the model is introduced in section *V*.

In what follows, we will assume that the technological intensity of the commodities is related to the technological gap in input efficiency independent of relative prices for the production of these commodities. The commodities are what we have called Ricardian commodities and are able to be produced both by the home and by the foreign country.

Let w and w^* denote the wages in the foreign and home economies, $W=w/w^*$ denotes the relative wages measured in each common commodity; $A(z)=\Pi(z)=\pi(z)/\pi^*(z)$ is the labour productivity function which ranks the produced commodities for the whole set in terms of an increasing technological gap. Thus, the borderline commodity $\tilde{z}$, which determines the pattern of specialisation, can be written as the following function:

$$\tilde{z}=\tilde{z}\left[W(t),\Pi(z,t)\right] \tag{18}$$

Differentiating equation (18) we obtain the changes of $\tilde{z}$ over time, under the assumption of exogenous technical progress in the production of existing commodities as also result from equation (12), which are described by the following equation:

$$\dot{\tilde{z}}=\psi\left[\left(\dot{w}-\dot{w}^*\right)+\left(\dot{\pi}^*-\dot{\pi}\right)\right] \tag{19}$$

where $\dot{w}$, $\dot{\pi}$ and $\dot{w}^*$, $\dot{\pi}^*$ are the per cent changes in wages and labour productivities in the foreign and home countries, respectively.

Equation (19) can be considered as the basis for the analyses of the dynamics of comparative (dis) advantages which are related to the differences in the existing technological capabilities in the production of the Ricardian commodities and the dynamics of relative wages and productivities. There is therefore a limit as to how far the dynamics of comparative (dis)advantages can induce changes in specialisation when the existing technological multiplier is already small. Conversely, in the case of a large technological multiplier, adjustments in the pattern of specialisation will be very sensitive to changes in comparative (dis)advantages.

II) The Harrod foreign trade and technological gap multipliers

Let us analyse how the comparative advantages and the dynamics of specialisation are introduced in a open macro-economic framework. In general, the composition and dynamics of specialisation flows are interpreted within a framework characterised by different sector-specific technological gaps between countries as introduced in the previous section, by generally non-clearing markets and by Keynesian-Kaldorian links between international competitiveness and the process that explains the general stylised facts of uneven growth as opposed to the particular case of balanced growth.

Let us start by specifying the national consumption pattern as it has been introduced in the first part. Assuming that $o<\tilde{z}<z_0$, which defines the limit of changes in the pattern of specialisation between foreign and the home country from changes in wages, we may write,

(20)

$$\Gamma(\beta,\tilde{z}) = \int_{0}^{\tilde{z}} \beta(z)dz$$

(21)

$$\Gamma^*\left(\beta^*,\tilde{z},z_0\right) = \int_{\tilde{z}}^{z_0} \beta^*(z)dz$$

where,

Γ is the foreign share of wages spent on the Ricardian commodities produced in the home country; Γ^* is the home share of wages spent on the Ricardian commodities produced in the foreign country; $\beta(z)$ and $\beta^*(z)$ are defined in equations (2) and (3).

In order now to obtain an expression of the Balance of Trade Equilibrium Condition, we must specify the total home imports and exports. These can be expressed as:

$$M^*=Y^*\Gamma^*(\beta^*,\tilde{z},z_0) \tag{22}$$

$$X^*=Y\,\Gamma(\beta,\tilde{z}) \tag{23}$$

where M^* is the total import demand in the home country, X^* is the home export (i.e. the import demand in the foreign country), Y^* and Y are the home and foreign incomes in which wages are the only component. Then the trade equilibrium condition is:

$$Y^* = \frac{\Gamma(\beta,\tilde{z})}{\Gamma^*(\beta^*,\tilde{z},z_0)}Y \tag{24}$$

The per cent changes in the domestic and foreign shares spent on the import of commodity z, $\dot{\beta}^*(z)$ and $\dot{\beta}(z)$, are the same as that obtained in equations (15) and (16), so that:

$$\dot{\beta}^*(z) = \dot{w}^*(\varepsilon^*(z)-1)+\dot{p}(z)(1-\eta^*(z)) \tag{25}$$

$$\dot{\beta}(z) = \dot{w}(\varepsilon(z)-1)+\dot{p}^*(z)(1-\eta(z)) \tag{26}$$

where ε^* and ε are the income elasticities, and η^* and η the price elasticities in the home and foreign country respectively. p(z) and $p^*(z)$ are the prices of commodity z produced in the foreign and home country, which are defined respectively as $p(z)=w/p(z)$ and $p^*=w^*/\pi^*(z)$; thus the double factoral terms of trade will be given by $W=w/w^*$. Equations (25) and (26) capture the demand absorption and price effects; note that the changes in prices can be decomposed as: $\dot{p}=\dot{w}-\dot{\pi}$ and $\dot{p}^*=\dot{w}^*-\dot{\pi}^*$.

In this respect, the changes in the real wage affect the demand for imports, the impact of which is weighted by the price and income elasticities of each commodity, and the range of commodities produced and exported by both countries. The impact of the latter effect is itself determined by the relative differences in productivities, defined as the technological gap. By introducing the possibility of changes in the pattern of specialisation, we will be able to link the technological gap and differences in demand structure, which will simultaneously explain the cases of uneven and balanced growth.

The per cent change in the domestic relative income then follows from the following equation:

$$\dot{Y}^* - \dot{Y} = \dot{w}\overline{\varepsilon} - \dot{w}^*\overline{\varepsilon}^* + \dot{w}^*\overline{\eta} - \dot{w}\overline{\eta}^* + \dot{\pi}\overline{\eta}^* - \dot{\pi}^*\overline{\eta} + (\dot{\tilde{z}}/\psi)M \tag{27}$$

where: $M=\psi\tilde{z}(\beta^*(z)/\Gamma^*+\beta(z)/\Gamma)$, $\overline{\varepsilon} = \frac{1}{\Gamma}\int_0^{\tilde{z}}(\varepsilon(z)-1)\beta(z)dz$,

$$\overline{\varepsilon}^* = \frac{1}{\Gamma^*}\int_{\tilde{z}}^{z_0}(\varepsilon^*-1)\beta^*(z)dz, \overline{\eta} = \frac{1}{\Gamma}\int_0^{\tilde{z}}(1-\eta(z))\beta(z)dz, \overline{\eta}^* = \frac{1}{\Gamma^*}\int_{\tilde{z}}^{z_0}(\eta^*-1)\beta^*(z)dz.$$

Equation (27) illustrates how the domestic relative rate of growth compatible with the trade balance constraint is a function of: (a) the difference in the consumption pattern between the two countries (i.e. the income and price elasticities in both economies); (b) the changes in the per capita demand absorption of imported commodities and the changes in relative prices and/or factoral terms of trade (i.e. $\dot{\beta}^*$ and $\dot{\beta}$); and (c) the technological multiplier and the relative changes in the pattern of specialisation (i.e. ψ).

As emerges from the first part, the net effect on domestic relative income will depend on how these changes are compensated. Changes in wages and productivities not only have an impact on prices and demand for imports, but also on the dynamics of comparative (dis)advantages and specialisation. In this context, the technological gap multiplier assumes a multiplicative form which can amplify or reduce the effect of specialisation over the growth rate differential. This model can thus become an adequate representation of international differences in growth rate, whenever the technological capabilities, the regimes of national consumption formation, and the institutional set-ups that relate wages and productivities are asymmetric/symmetric and not stable over time.

III) Dynamic economies of scale and cumulative learning in comparative (dis)advantages

The model introduced here can be considered a sort of "theoretical abacus" which reproduces different scenarios characterised by specific linkages between technology gaps, dynamics of (dis)advantages, specialisation and the growth rate differential. In a general view, different scenarios can be represented on the basis of how the dynamics of productivities, wages and their interplay are introduced. As set out in Vaglio (1988), we shall use a sort of accumulative Verdoorn-Kaldor law that explains the dynamics of productivity in both countries and introduces a clear mechanism of dynamics economies of scale. Labour productivity depends on the cumulative output and the learning capabilities over time creating a process of strong irreversibility which, moreover, is uniformly distributed in the producing sectors. Let us now introduce an explicit form of the Verdoorn-Kaldor law[11] ,

$$\pi = Y^{\alpha} \qquad 0<\alpha<1$$
$$\pi^* = Y^{*\gamma} \qquad 0<\gamma<1 \tag{28}$$

where α and γ are the Verdoorn-Kaldor parameters in the foreign and home countries. Y and Y^* are the cumulative capabilities in each economy, which are defined as follows,

$$Y(t)=\int_0^t (y(t)+\delta y^*(t))dt, \qquad Y^*(t)=\int_0^t (y^*(t)+\delta y(t))dt, \tag{29}$$

δ can be considered as a parameter that indicates how much the cumulative capabilities are related to the internationalisation of the learning process, $0\leq\delta\leq.1$ In other words, the parameter δ can represent the international learning spill-over which symmetrically influences the cumulative capabilities in both economies. $\delta=0$ indicates that the cumulated and learning capabilities are related only to local effort or that the country does not assimilate international learning spill-overs. $\delta=1$ indicates that the capabilities are explained in terms of the world economy as a whole and that technology can easily be obtained from abroad; in this case the assimilated learning spill-overs reach the maximum value.

[11] In a similar structuralist view of trade and growth, the endogenously technical change and increasing returns to scale on the basis of the Kaldor-Verdoorn are introduced in Amable (1992), (1993) and Boggio (1993).

As we indicated earlier, the productivities in both economies are related to a sort of cumulative-learning Verdoorn-Kaldor law which determines the following dynamics of relative productivity:

(30)

$$\frac{\dot{\pi}}{\dot{\pi}^*} = \frac{\alpha(\pi^*)^{1/\gamma}(y+\delta y^*)}{\gamma(\pi)^{1/\alpha}(y^*+\delta y)}$$

The relative dynamics of productivity ($\dot{\pi}/\dot{\pi}^*$) is a negatively-sloped function with respect to the relative productivities (π/π^*). This equation is solvable for π/π^* on the basis of different values of relative incomes and the parameters indicated in the equation (α, γ and δ). Thus, there exists an equilibrium value of π/π^* for which the rate of productivity growth is the same in both economies, that is $\dot{\pi}/\dot{\pi}^*=1$, and the equilibrium value will be reached in the domain of positive productivity in both economies. Figure 4 shows a family of curves which emerges from equation (30) for different γ and fixed α and δ; thus, for each curve the relative productivities reach an equilibrium value for which $\dot{\pi}/\dot{\pi}^*=1$. In Figure 4, when $\delta=1$, there exists a family of curves which determines a sequence of equilibrium values of relative productivities in terms of the Verdoorn-Kaldor parameters in both economies. The curve characterised by $\alpha=0.1$ and $\gamma=0.2$ reaches an equilibrium value for $(\pi/\pi^*)^*$ which moves to the left side when γ increases and to the right side when γ decreases (see Appendix-fig. 4).

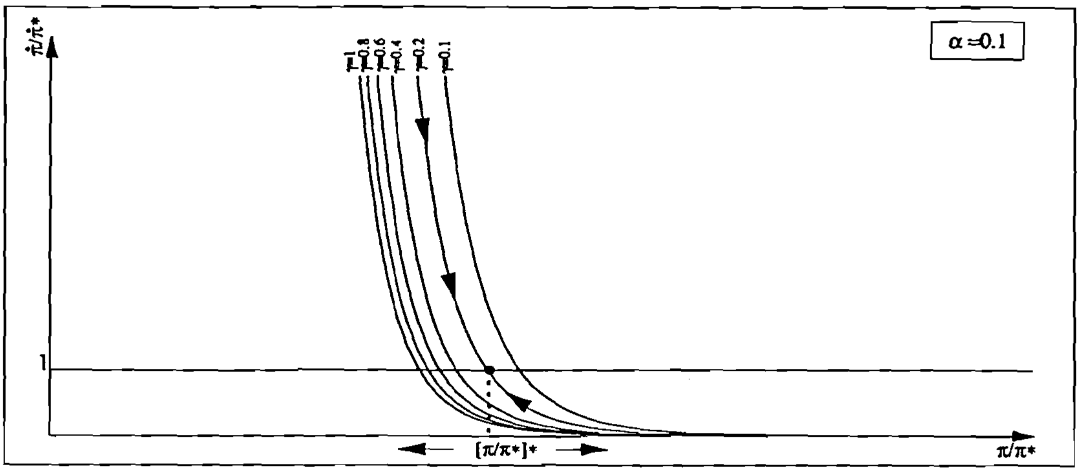

Figure 4 Dynamics of comparative (Dis) Advantages and Specialization

In the particular case of a world characterised by perfect symmetric economies $\gamma=\alpha$, we found that the equilibrium value is $\pi/\pi^*=1$. When $\gamma>\alpha$ the equilibrium value of relative productivities is lower with respect to the perfect symmetric economies, and conversely for $\gamma<\alpha$.

Moreover, the equilibrium value of (π/π^*) can be considered as a function of (y/y^*). Taking equation (30) and solving it for the equilibrium value of the productivities that guarantee the same rate in both economies, we obtain the relative incomes:

(31)

$$\frac{y}{y^*}=\frac{\delta(\alpha/\gamma)(\pi/\pi^*)^{-(1/\alpha)}\pi^{*(1/\gamma-1/\alpha)}-1}{\delta-(\alpha/\gamma)(\pi/\pi^*)^{-(1/\alpha)}\pi^{*(1/\gamma-1/\alpha)}}$$

the two extreme cases that determine the domain of this function are:

$$(y/y^*)\to 0 \Rightarrow (\pi/\pi^*)^0=(\delta\alpha/\gamma)^{\alpha}\pi^{*(\alpha/\gamma-1)}$$
$$(y/y^*)\to \infty \Rightarrow (\pi/\pi^*)^1=(\alpha/\delta\gamma)^{\alpha}\pi^{*(\alpha/\gamma-1)}$$

which results for $\delta\neq 1$. Equation (31) describes a family of curves for different values of relative incomes (y/y^*), determining two extreme values of equilibrium for the relative productivities; thus, when the relative incomes increase, the equilibrium value moves to $(\pi/\pi^*)^1$; when the relative incomes decrease, the value of equilibrium reached is $(\pi/\pi^*)^0$.

Equation (30) enables us to seek an equilibrium value of the relative productivities which determine a steady state solution of comparative advantages for given relative wages $(\dot{w}=\dot{w}^*=0)$. Consequently, from equation (19) when an equilibrium is reached it results that $\dot{\bar{z}}=0$ and, thus, a pattern of specialisation is endogenously determined on the basis of the interaction of the learning mechanism between the trading economies.

Two cases can be underlined. First, when the spill-over effect reaches its maximum value $\delta=1$, the world economy is characterised by the possibility that the technological knowledge and experience is easily transferred. In this case, the equilibrium solution of relative productivities and specialisation is determined only by the differences in local learning effort of each country and its cumulative effect.

Second, when $0\leq\delta<1$, and, consequently, a world economy characterised by a non-perfect transferring of technological knowledge, the equilibrium solution and specialisation is determined by the local effort and the level of relative output of each economy. Thus, a country with a higher level of output will obtain a higher level of relative productivities and a pattern of specialisation with increased export.

IV) Dynamics in comparative (dis)advantages and specialisation

As emerges from equation (19), the dynamics of specialisation and the differences in the output rate of growth depends crucially on the rate of increase in wages and the modes of how this is related to the increase in productivity. We shall assume that the changes in wages are related to productivity as follows,

$$\dot{w}=\lambda\dot{\pi},\ 0\leq\lambda; \quad \text{and} \quad \dot{w}^*=\lambda^*\dot{\pi}^*,\ 0\leq\lambda^* \tag{32}$$

where λ and λ^* can be interpreted as an indicator of the wage-labour nexus that characterises these economies. Following the results emerging in the theory of regulation developed in Coriat and Saboia (1987), Boyer (1988a), (1988b), and Aboites (1988), this parameter can interpret the following two extreme cases or others between them. An oligopolistic form of regulation, where the wage-labour nexus is characterised by tacit or statutory mechanisms of strong indexation of wages to labour productivity, as happens in the most advanced economies, λ or λ^* are near one. A classical form of regulation, prevailing in the less developed economies, where the wage-labour nexus is determined by a weak indexation of wage to productivity in the larger part of the economy, λ or λ^* are near zero[12].

Substituting (32) in equation (19), gives an expression of the specialisation from which we can obtain the relative value of the dynamics of productivity that guarantees a stable pattern of specialisation,

$$\dot{\bar{z}}=\psi\left[\left(\lambda\dot{\pi}-\lambda^*\dot{\pi}^*\right)+\left(\dot{\pi}^*-\dot{\pi}\right)\right],\dot{\bar{z}}=0\Rightarrow\begin{cases}\psi=0\\ \dot{\pi}/\dot{\pi}^*=(\lambda^*-1)/(\lambda-1)\end{cases} \tag{33}$$

The changes in the specialisation are explained by: the existing technological gap multiplier, the dynamic increasing returns which determine the evolution of comparative advantages over time and the institutional wage-labour

[12] The model can be extended to the case where a wage is indexed with the productivity in one of the two countries and fixed in the other. In this case the model introduced here can represent the traditional result on the North-South models for the fundamental analysis developed in the Prebisch-Singer thesis and the Lewis approach, Cimoli (1988).

nexus prevailing in each economy. The pattern of specialisation is stable in two cases: *i)* when the technological gap multiplier is zero, *ii)* when the wage labour nexus is the same in both economies.

Now we may relate the mechanisms that explain the interplay between the endogenous dynamics of relative productivities, comparative advantage and specialisation. Equation (30) determines an equilibrium solution of relative productivities, for example $(\pi/\pi^*)^*$ in Figure 5. Moreover, as emerges from equation (16), $(\pi/\pi^*)^*$ always lies between $(\pi/\pi^*)^0$ and $(\pi/\pi^*)^1$. For these extreme values of relative productivities indicated in Figure 5, which are determined by the Verdoorn-Kaldor and internationalisation parameters, we found that the relative level of output will be radically in favour of one economy or the other (see Appendix-fig. 5).

The conditions that determine a stable pattern of specialisation are not necessarily compatible with the equilibrium, which tends to converge the relative dynamics of productivities. For each curve determined from equation (30), (π/π^*) will tend to converge on an equilibrium value for which, however, the dynamics of specialisation is not necessarily stable. Thus, as illustrated in Figure 5 and as emerges from equation (33), the pattern of specialisation is stable when $1=(\lambda^*-1)/(\lambda-1)$ or $\lambda^*=\lambda$, i.e., when the wage-labour nexus is the same in both economies. The specialisation is in favour of the home country when $1>(\lambda^*-1)/(\lambda-1)$ or $\lambda^*<\lambda$,

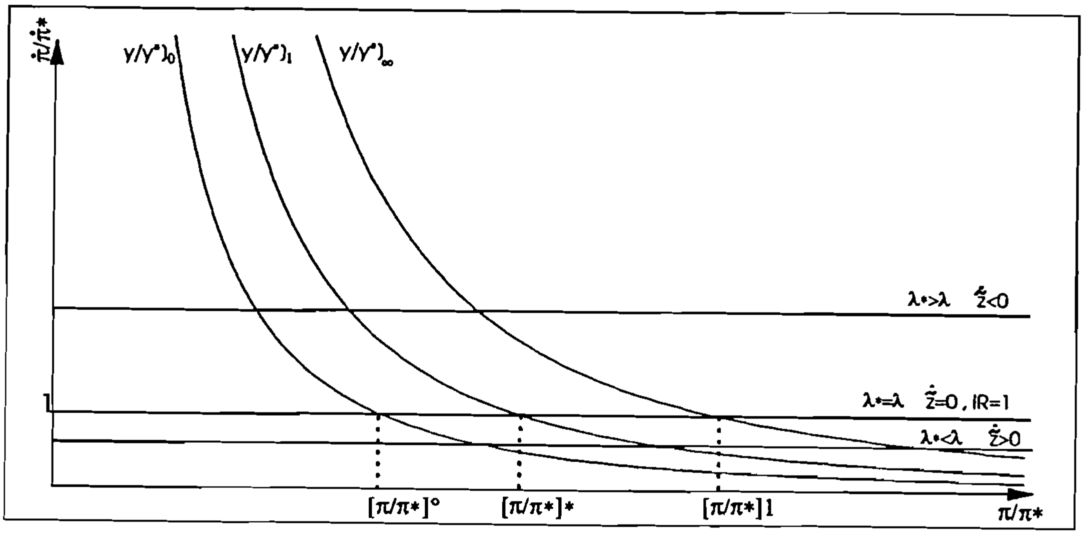

Figure 5 Dynamics of comparative (Dis) Advantages and Specialization

i.e., in the foreign economy the wage rises in line with productivity and the home wage is indexed more weakly; and, conversely, when the specialisation is in favour of the foreign economy, i.e., $1<(\lambda^*-1)/(\lambda-1)$ or $\lambda^*>\lambda$.

The dynamics of specialisation is related both to the way in which the dynamics of increasing returns and the specific institutional wage-labour nexus operating in each economy work. The equilibrium solution determined by the curves (y/y^*) in the range defined by $(\pi/\pi^*)^0$ and $(\pi/\pi^*)^1$ is compatible with a locking-in effect which reinforces the dynamics of the pattern of specialisation in favour of one country or the other.

In general, what clearly emerges from the interaction of comparative advantages and specialisation is that a stable pattern of specialisation (and/or a stable solution for the comparative advantages) requires not only that the cumulative elements which explain the dynamics of increasing returns and cumulative learning reach a stable equilibrium, but also that the institutional factors that explain the wage-labour nexus must be symmetric.

V) A solution of the model

Taking equation (27) and substituting (32) and (33) the growth rate differential is defined as:

$$\dot{Y}^* - \dot{Y} = \dot{\pi}(\lambda\bar{\varepsilon} + (\lambda - 1)(M - \bar{\eta}^*)) - \dot{\pi}^*(\lambda^*\bar{\varepsilon}^* - (\lambda^* - 1)(\bar{\eta} - M)) \tag{34}$$

The growth rate differential obtained is clearly related to dynamics of relative productivities, the changes in M which include the technological gap multiplier, the wage-labour nexus prevailing in each country and the average value of income and price elasticities. The equation system given by (30) and (34) determines the interplay that exists between the dynamics of comparative (dis) advantages, specialisation and growth rate differential. From equation (34) we can obtain the solution for which the growth rates of the outputs are the same in both economies when both the consumption pattern and the wage labour nexus differ,

$$\dot{y}^* - \dot{y} = 0 \Rightarrow \frac{\dot{\pi}}{\dot{\pi}^*} = \boldsymbol{R} = \frac{(\lambda^* - 1)(M - \bar{\eta}) + \lambda^*\bar{\varepsilon}^*}{(\lambda - 1)(M - \bar{\eta}^*) + \lambda\bar{\varepsilon}} \tag{35}$$

where $\boldsymbol{R}$ is the curve that guarantees that the growth rates are balanced in both economies.

From equation (35) it emerges that the specialisation is stable and both economies grow at the same rate when $\dot{y}^*-\dot{y}=0$ and $1=\boldsymbol{R}$. To obtain the same rate of output growth it is not sufficient for the relative productivities to reach an equilibrium solution and the pattern of specialisation not to change over time. Therefore, a stable pattern of comparative advantages and specialisation is necessary but not sufficient to produce balanced growth. Thus, we can obtain balanced growth when the specialisation does not change over time and the consumption pattern is perfectly symmetric.

As is illustrated in Figure 5, for a stable specialisation and balanced growth $\dot{\tilde{z}}=0$ and $1=\boldsymbol{R}$, the equilibrium value of relative productivities always lies between the two extreme values of $(\pi/\pi)^0$ and $(\pi/\pi)^1$ and is determined by the curve (y/y^*); for example for $(y/y^*)_1$ we obtain $(\pi/\pi)^*$. Thus, when both economies are perfectly symmetric in consumption patterns and wage-labour nexus, the equilibrium solution is only explained by the mechanisms that describe the dynamics of increasing returns for a stable level of relative output.

In general, a process of divergence in the rate of growth can result under the general solution of equation (30), which shows that the dynamics of relative productivities will converge to an equilibrium. A pattern of divergence in the rate of growth is explained by the asymmetries in the consumption pattern at national level, due to the pattern of specialisation that has emerged ($\bar{\varepsilon}\neq\bar{\varepsilon}^*$, $\bar{\eta}\neq\bar{\eta}^*$, $\lambda=\lambda^*$). Another pattern of divergence in the rate of growth results when the consumption patterns are symmetric and the wage labour nexus differ ($\bar{\varepsilon}=\bar{\varepsilon}^*$, $\bar{\eta}=\bar{\eta}^*$, $\lambda\neq\lambda^*$). In this case, the locking-in effect in the specialisation determines an increasing dynamics divergence in the rate of growth.

To solve the model, in the case of asymmetries in wage-labour nexus and national consumption patterns, we shall find the effective value of the specialisation $\tilde{z}$ and $\boldsymbol{R}$. Taking equations (33), (34) and (20), the specialisation and the condition that guarantee the same rate of growth can be rewritten as a function of relative productivity:

$$\tilde{z} = e^{\Psi} \frac{(\pi^*)^{\Psi(1-\lambda^*)}}{(\pi)^{\Psi(1-\lambda)}} \tag{36}$$

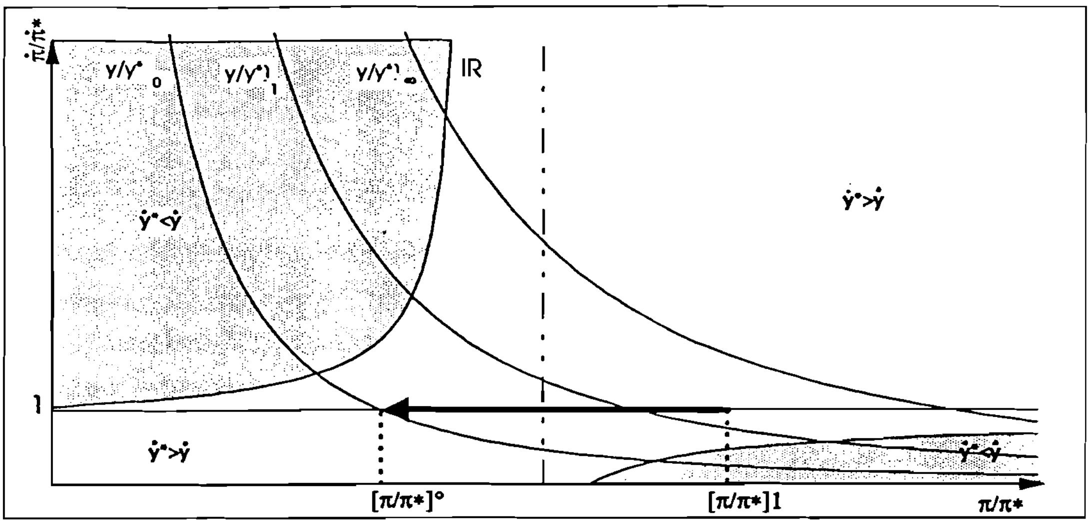

Figure 6. Dynamics of comparative (Dis) Advantages and Convercence
vs Divergence in the Gorwth rate differential

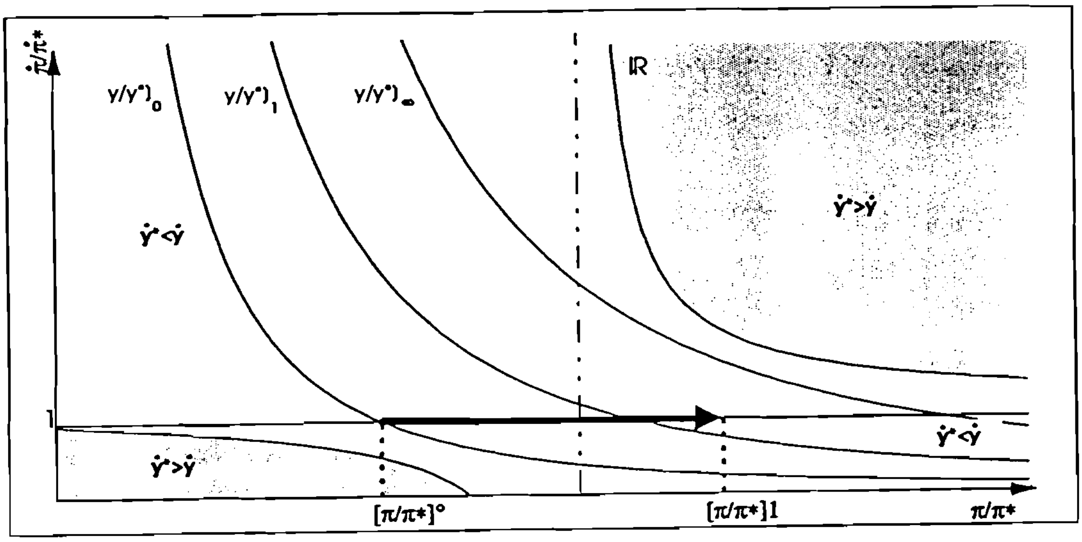

Figure 7. Dynamics of comparative (Dis) Advantages and Convercence
vs Divergence in the Gorwth rate differential

$$R = \frac{(\lambda^* - 1)\left(\beta\psi e^{\psi}\frac{(\pi)^{\psi(\lambda-1)}}{(\pi^*)^{\psi(\lambda^*-1)}} - \overline{\eta}\right) + \lambda^*\overline{\varepsilon}^*}{(\lambda - 1)\left(\beta\psi e^{\psi}\frac{(\pi)^{\psi(\lambda-1)}}{(\pi^*)^{\psi(\lambda^*-1)}} - \overline{\eta}^*\right) + \lambda\overline{\varepsilon}} \tag{37}$$

where $\beta = (\beta^*(z)/\Gamma^* + \beta(z)/\Gamma)$. From equation (30) the relative productivity will converge to an equilibrium value for which $\dot{\pi}/\dot{\pi}^*=1$. However, when there is some asymmetry in wage-labour nexus or national consumption pattern, the rates of growth diverge and ***R*** changes with respect to the relative productivities. The curves ***R***, in Figure (6) and (7), indicate the areas where the growth-rate differential is in favour of one country or the other. ***R*** depicts the case where the only asymmetry is related to the national consumption pattern (see Appendix-fig. 6 and Appendix-fig. 7).

This situation starts up a process where a growth rate differential in favour of one economy or the other changes the equilibrium value of relative productivities. There is a virtuous circle where output growth rate is a source which continuously moves the equilibrium solution for the relative productivities and increases the divergence between countries. For example, this process moves the equilibrium solution to the left when $\eta<\overline{\eta}^*$ and the rate of income growth is higher in the home economy (Figure 6); and, conversely, the equilibrium solution moves to the right when $\eta>\overline{\eta}^*$ and the growth rate differential is in favour of the foreign economy (Figure 7). The cases depicted here reproduce a situation for which the country with exports characterised by higher price elasticities obtains a higher output rate of growth. This effect is due to the increasing price competitiveness when the exported commodities are elastic and the national consumption pattern asymmetric. The same can be applied for the differences in income elasticities and wage-labour nexus, i.e. $\overline{\varepsilon}\neq\overline{\varepsilon}^*$ and $\lambda\neq\lambda^*$. Thus, under a symmetric pattern of learning and dynamic increasing returns, the growth rate differential is explained by the differences in the consumption pattern.

These pictures describe a process of multiple equilibrium which continuously moves the equilibrium solution to $(\pi/\pi^*)^0$ or $(\pi/\pi^*)^1$, as is shown in Figure 6 and 7. However, when the growth rate of output diverges, the equilibrium value will converge to one of the two extreme solutions which are determined mainly by the Verdoorn-Kaldor and internationalisation parameters. For $(y/y^*)\rightarrow 0$

the value of relative productivities will tend to $(\pi/\pi^*)^0$ and, conversely, for (y/y)→∞ the solution will converge to $(\pi/\pi^*)^1$.

A solution for specialisation and relative income, in the case of differences in price elasticities, is represented in Figure 5 (see Appendix-fig. 8). Taking equations (34) and (35), we obtain:

$$\tilde{z} = e\psi\left(\frac{\pi^*}{\pi}\right)^{\psi} \quad \text{and} \quad \frac{y^*}{y} = \frac{(\pi)^{\eta}}{(\pi^*)^{\eta}} e^{\left(2\beta e^{\psi}(\pi^*/\pi)^{\psi}\right)}$$

The value of $\tilde{z}$ and (y/y^*) lies between the two extreme values of productivities determined by $(\pi/\pi^*)^0$ and $(\pi/\pi^*)^1$ or tends to one of the two extremes, whereas the shape of the curves are influenced by the technological gap multiplier. When both economies are perfectly symmetric, the equilibrium solution will be determined at a point within the interval. The two extreme cases will be reached when the growth rate of output diverges.

Thus, two scenarios emerge from this solution. The first scenario is associated to the case of perfect symmetric economies in the national consumption patterns and wage labour nexus under stable dynamics in the relative dynamics of productivities and comparative advantages. The trade and growth pattern will reach an equilibrium solution which will be localised between $(\pi/\pi^*)^0$ and $(\pi/\pi^*)^1$ determining $\tilde{z}$ and (y/y^*). For example, in Figure 8, for $(\pi/\pi^*)^*$ we obtain $(\tilde{z})^*$ and $(y/y^*)^*$.

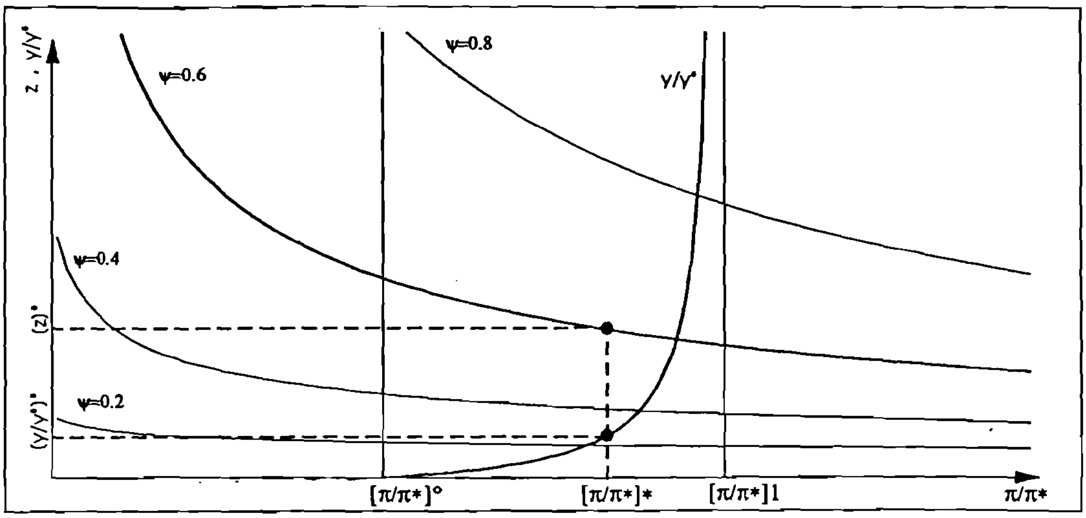

Figure 8. A solution for the model : specialization and output

The second scenario is related to a situation of forging ahead and falling behind under a stable situation in the dynamics of relative productivities (see Figures 6 and 7). The economies are asymmetric in the consumption patterns and wage-labour nexus. The process of uneven growth will move the equilibrium solution to $(\pi/\pi^*)^0$ or $(\pi/\pi^*)^1$ according to the differences in the output rate of growth which can be in favour of one country or the other. As is indicated in Figure 8, if the growth differential is in favour of the home country, the equilibrium solution will reach $(\pi/\pi^*)^0$, and if the opposite happens the equilibrium solution will reach $(\pi/\pi^*)^1$.

Conclusions

Even though the model presented here was highly stylised and restrictive in its assumptions about the nature of technological change and the international differences in technological capabilities, a number of interesting features with respect to technological catching up, patterns of specialisation and relative income growth emerge from the broad, generalised two country model presented here.

On the one hand, the model points to the importance of the interplay between absolute and comparative advantages as determinants of the participation of each country in world trade, and to the dominance of technological gaps in the process of international specialisation which provides the outer-boundaries of the Keynesian process of change of the level income and the growth possibility "sets" of each economy. On the other hand, the model presented here provides a link between the conditions for the changes of international specialisation and the "Keynesian" determination of the level of activity in open economies.

In contrast to previous analyses, this was done here formally introducing the concept of technological gap multiplier. This is a concept that can be considered as a straightforward approximation of the empirical fact that products can be ranked in terms of their technological intensity which allows us to analyse in a more formal and systematic way the impact of large and small technological gaps between countries on the pattern of specialisation and the domestic relative rate of growth.

From this perspective the model presented here is truly generalisable, allowing us to derive both the more traditional balance of payments constrained growth results, as well as the more technology specific North-South trade models.

The introduction of endogenous dynamics increasing returns is displayed in the model by a mechanism which produces a stable equilibrium solution.

However, the dynamics of comparative (dis)advantages and specialisation generated here can converge to a steady-state solution or reproduce a locking-in effect which reinforces the dynamics of the pattern of specialisation in favour of one country or the other.

A scenario of stable pattern of specialisation results in the case of symmetric wage-labour nexus in trading economies. Thus, the equilibrium solution in comparative (dis)advantages and specialisation will move in favour of one economy or the other according to the Verdoorn-Kaldor parameters and the internationalisation in the technological transfer process. A scenario of locking-in effect in the specialisation results when both trading economies are characterised by an asymmetric wage labour nexus.

Moreover, a scenario of stable equilibrium solution of comparative (dis)advantages and pattern of specialisation is not a sufficient condition to produce a balanced growth path. To obtain a path of balanced growth, the emerged pattern of specialisation has to be associated to a symmetric national pattern of consumption. Thus, the mechanism of dynamics increasing returns and cumulative learning, on the one hand, could determine a stable pattern of specialisation. On the other hand, the resulting pattern of specialisation can produce a national pattern of consumption which may or may not be compatible with a balanced path of growth.

A general outcome of the model is that a balanced and convergent path in the growth rates is a particular case where a stable equilibrium in the comparative (dis)advantages produces a stable pattern of specialisation and determines a symmetric national consumption pattern over time. A divergent path is related to a pattern of specialisation associated to a national consumption pattern which shows structural asymmetries between countries. If the equilibrium solution in the specialisation is associated to an asymmetric pattern of national consumption, a divergence in the rate of output growth will emerge. Thus, a stable pattern of specialisation can determine a pattern of national consumption which originates a process of locking-in effect in the specialisation and self-reinforcing mechanisms in the divergence of the output rate of growth.

The model presents a paradoxical result associated to the perspective of falling behind or forging ahead as the technological learning and accumulation for the sectoral activities interact with the national consumption patterns which are asymmetrical at the national level. If a country shows high dynamics of increasing returns and learning capabilities in the sectors where the consumption pattern is not favourable, it may result in a process of falling behind. In the case of low dynamics of increasing returns and a favourable consumption pattern, a country may find a process of catching up or forging ahead. Thus, the possibility of forging ahead and convergence are guaranteed when the learning capabilities are distributed in those activities associated to a favourable national consumption pattern.

Appendix-Figure 4

	α=	0,1	0,1	0,1	0,1	0,1	0,1
π/π*	γ=	0,1	0,2	0,4	0,6	0,8	1
0,05	1	1,02E+13	5,12E+12	2,56E+12	1,71E+12	1,28E+12	1,02E+12
0,07	1	3,54E+11	1,77E+11	8,85E+10	5,9E+10	4,43E+10	3,54E+10
0,09	1	2,87E+10	1,43E+10	7,17E+09	4,78E+09	3,58E+09	2,87E+09
0,11	1	3,86E+09	1,93E+09	9,64E+08	6,43E+08	4,82E+08	3,86E+08
0,13	1	7,25E+08	3,63E+08	1,81E+08	1,21E+08	90672688	72538150
0,15	1	1,73E+08	86707650	43353825	28902550	21676912	17341530
0,17	1	49603325	24801662	12400831	8267221	6200416	4960332
0,19	1	16310377	8155188	4077594	2718396	2038797	1631038
0,21	1	5995247	2997623	1498812	999207,8	749405,8	599524,7
0,23	1	2413913	1206957	603478,3	402318,9	301739,1	241391,3
0,25	1	1048576	524288	262144	174762,7	131072	104857,6
0,27	1	485693,6	242846,8	121423,4	80948,93	60711,7	48569,36
0,29	1	237695	118847,5	59423,75	39615,83	29711,87	23769,5
0,31	1	122006,5	61003,26	30501,63	20334,42	15250,82	12200,65
0,33	1	65292,09	32646,05	16323,02	10882,02	8161,512	6529,209
0,35	1	36250,96	18125,48	9062,741	6041,827	4531,37	3625,096
0,37	1	20796,14	10398,07	5199,035	3466,024	2599,518	2079,614
0,39	1	12284,4	6142,2	3071,1	2047,4	1535,55	1228,44
0,41	1	7450,089	3725,044	1862,522	1241,681	931,2611	745,0089
0,43	1	4627,17	2313,585	1156,792	771,195	578,3962	462,717
0,45	1	2936,803	1468,402	734,2008	489,4672	367,1004	293,6803
0,47	1	1901,172	950,586	475,293	316,862	237,6465	190,1172
0,49	1	1253,254	626,6271	313,3136	208,8757	156,6568	125,3254
0,51	1	840,0367	420,0183	210,0092	140,0061	105,0046	84,00367
0,53	1	571,7963	285,8981	142,9491	95,29938	71,47453	57,17963
0,55	1	394,7963	197,3982	98,69908	65,79939	49,34954	39,47963
0,57	1	276,2177	138,1088	69,05442	46,03628	34,52721	27,62177
0,59	1	195,65	97,82501	48,9125	32,60834	24,45625	19,565
0,61	1	140,185	70,09252	35,04626	23,36417	17,52313	14,0185
0,63	1	101,53	50,76501	25,38251	16,92167	12,69125	10,153
0,65	1	74,27907	37,13953	18,56977	12,37984	9,284883	7,427907
0,67	1	54,85952	27,42976	13,71488	9,143253	6,85744	5,485952
0,69	1	40,87983	20,43992	10,21996	6,813305	5,109979	4,087983
0,71	1	30,71967	15,35983	7,679917	5,119945	3,839958	3,071967
0,73	1	23,26866	11,63433	5,817165	3,87811	2,908583	2,326866
0,75	1	17,75773	8,878863	4,439432	2,959621	2,219716	1,775773
0,77	1	13,64875	6,824373	3,412186	2,274791	1,706093	1,364875
0,79	1	10,56158	5,280792	2,640396	1,760264	1,320198	1,056158
0,81	1	8,225263	4,112632	2,056316	1,370877	1,028158	0,822526
0,83	1	6,444943	3,222471	1,611236	1,074157	0,805618	0,644494
0,85	1	5,07938	2,53969	1,269845	0,846563	0,634923	0,507938
0,87	1	4,025385	2,012693	1,006346	0,670898	0,503173	0,402539
0,89	1	3,207007	1,603504	0,801752	0,534501	0,400876	0,320701
0,91	1	2,567947	1,283974	0,641987	0,427991	0,320993	0,256795
0,93	1	2,066191	1,033096	0,516548	0,344365	0,258274	0,206619
0,95	1	1,670183	0,835091	0,417546	0,278364	0,208773	0,167018
0,97	1	1,356072	0,678036	0,339018	0,226012	0,169509	0,135607
0,99	1	1,105727	0,552864	0,276432	0,184288	0,138216	0,110573
1,01	1	0,905287	0,452643	0,226322	0,150881	0,113161	0,090529
1,03	1	0,744094	0,372047	0,186023	0,124016	0,093012	0,074409
1,05	1	0,613913	0,306957	0,153478	0,102319	0,076739	0,061391
1,07	1	0,508349	0,254175	0,127087	0,084725	0,063544	0,050835
1,09	1	0,422411	0,211205	0,105603	0,070402	0,052801	0,042241
1,11	1	0,352184	0,176092	0,088046	0,058697	0,044023	0,035218
1,13	1	0,294588	0,147294	0,073647	0,049098	0,036824	0,029459
1,15	1	0,247185	0,123592	0,061796	0,041197	0,030898	0,024718
1,17	1	0,208037	0,104019	0,052009	0,034673	0,026005	0,020804

1,19	1	0,175602	0,087801	0,043901	0,029267	0,02195	0,01756
1,21	1	0,148644	0,074322	0,037161	0,024774	0,01858	0,014864
1,23	1	0,126168	0,063084	0,031542	0,021028	0,015771	0,012617
1,25	1	0,107374	0,053687	0,026844	0,017896	0,013422	0,010737
1,27	1	0,091614	0,045807	0,022904	0,015269	0,011452	0,009161
1,29	1	0,078362	0,039181	0,01959	0,01306	0,009795	0,007836
1,31	1	0,067187	0,033594	0,016797	0,011198	0,008398	0,006719
1,33	1	0,057741	0,02887	0,014435	0,009623	0,007218	0,005774
1,35	1	0,049735	0,024868	0,012434	0,008289	0,006217	0,004974
1,37	1	0,042933	0,021467	0,010733	0,007156	0,005367	0,004293
1,39	1	0,037141	0,01857	0,009285	0,00619	0,004643	0,003714
1,41	1	0,032197	0,016098	0,008049	0,005366	0,004025	0,00322
1,43	1	0,027967	0,013983	0,006992	0,004661	0,003496	0,002797
1,45	1	0,02434	0,01217	0,006085	0,004057	0,003042	0,002434
1,47	1	0,021224	0,010612	0,005306	0,003537	0,002653	0,002122
1,49	1	0,018541	0,009271	0,004635	0,00309	0,002318	0,001854
1,51	1	0,016227	0,008113	0,004057	0,002704	0,002028	0,001623
1,53	1	0,014226	0,007113	0,003557	0,002371	0,001778	0,001423
1,55	1	0,012493	0,006247	0,003123	0,002082	0,001562	0,001249
1,57	1	0,01099	0,005495	0,002748	0,001832	0,001374	0,001099
1,59	1	0,009683	0,004842	0,002421	0,001614	0,00121	0,000968
1,61	1	0,008546	0,004273	0,002136	0,001424	0,001068	0,000855
1,63	1	0,007553	0,003777	0,001888	0,001259	0,000944	0,000755
1,65	1	0,006686	0,003343	0,001671	0,001114	0,000836	0,000669
1,67	1	0,005927	0,002964	0,001482	0,000988	0,000741	0,000593
1,69	1	0,005262	0,002631	0,001315	0,000877	0,000658	0,000526
1,71	1	0,004678	0,002339	0,001169	0,00078	0,000585	0,000468
1,73	1	0,004164	0,002082	0,001041	0,000694	0,000521	0,000416
1,75	1	0,003712	0,001856	0,000928	0,000619	0,000464	0,000371
1,77	1	0,003313	0,001657	0,000828	0,000552	0,000414	0,000331
1,79	1	0,002961	0,001481	0,00074	0,000494	0,00037	0,000296
1,81	1	0,00265	0,001325	0,000662	0,000442	0,000331	0,000265
1,83	1	0,002374	0,001187	0,000594	0,000396	0,000297	0,000237
1,85	1	0,00213	0,001065	0,000532	0,000355	0,000266	0,000213
1,87	1	0,001912	0,000956	0,000478	0,000319	0,000239	0,000191
1,89	1	0,001719	0,00086	0,00043	0,000287	0,000215	0,000172
1,91	1	0,001548	0,000774	0,000387	0,000258	0,000193	0,000155
1,93	1	0,001395	0,000697	0,000349	0,000232	0,000174	0,000139
1,95	1	0,001258	0,000629	0,000314	0,00021	0,000157	0,000126
1,97	1	0,001136	0,000568	0,000284	0,000189	0,000142	0,000114
1,99	1	0,001027	0,000513	0,000257	0,000171	0,000128	0,000103
2,01	1	0,000929	0,000465	0,000232	0,000155	0,000116	9,29E-05
2,03	1	0,000841	0,000421	0,00021	0,00014	0,000105	8,41E-05
2,05	1	0,000763	0,000381	0,000191	0,000127	9,54E-05	7,63E-05

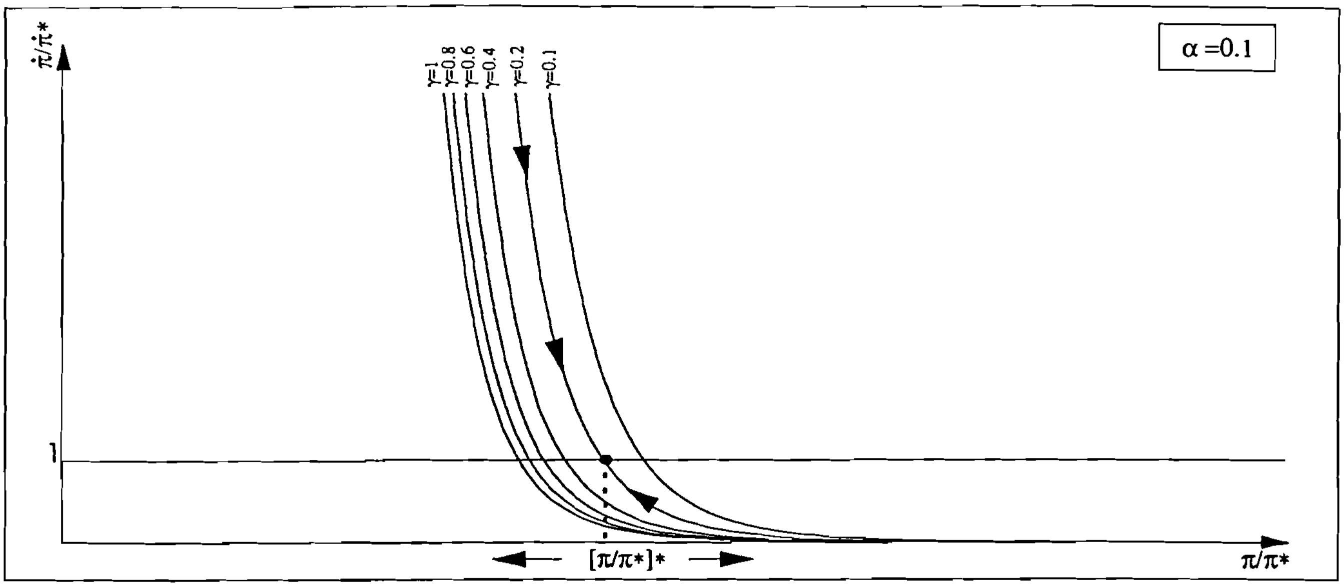

Figure ., Dynamics of comparative (Dis) Advantages and Specialization

Figure				
α =	0,5			
γ=	0,5			
δ=	0,5			
π* =	1			
C =	4			
η* =	1,1			
ψ =	0,4			
β =	0,53			
η =	1			
	y/y*)o	y/y*)1	y/y*)	IR
π/π*	1,00E-06	1	1000000	
0,05	200,0003	400,0000	799,9988	1,0420
0,07	102,0410	204,0816	408,1627	1,0515
0,09	61,7285	123,4568	246,9132	1,0606
0,11	41,3224	82,6446	165,2890	1,0695
0,13	29,5858	59,1716	118,3430	1,0784
0,15	22,2223	44,4444	88,8888	1,0875
0,17	17,3011	34,6021	69,2040	1,0968
0,19	13,8504	27,7008	55,4016	1,1063
0,21	11,3379	22,6757	45,3514	1,1162
0,23	9,4518	18,9036	37,8071	1,1265
0,25	8,0000	16,0000	32,0000	1,1373
0,27	6,8587	13,7174	27,4348	1,1486
0,29	5,9453	11,8906	23,7812	1,1606
0,31	5,2029	10,4058	20,8116	1,1732
0,33	4,5914	9,1827	18,3654	1,1865
0,35	4,0816	8,1633	16,3265	1,2008
0,37	3,6523	7,3046	14,6092	1,2160
0,39	3,2873	6,5746	13,1492	1,2324
0,41	2,9744	5,9488	11,8977	1,2500
0,43	2,7042	5,4083	10,8166	1,2690
0,45	2,4691	4,9383	9,8765	1,2897
0,47	2,2635	4,5269	9,0539	1,3122
0,49	2,0825	4,1649	8,3299	1,3369
0,51	1,9223	3,8447	7,6893	1,3642
0,53	1,7800	3,5600	7,1200	1,3943
0,55	1,6529	3,3058	6,6116	1,4279
0,57	1,5389	3,0779	6,1557	1,4656
0,59	1,4364	2,8727	5,7455	1,5082
0,61	1,3437	2,6874	5,3749	1,5568
0,63	1,2598	2,5195	5,0390	1,6128
0,65	1,1834	2,3669	4,7337	1,6780
0,67	1,1138	2,2277	4,4553	1,7549
0,69	1,0502	2,1004	4,2008	1,8471
0,71	0,9919	1,9837	3,9675	1,9596
0,73	0,9383	1,8765	3,7530	2,1000
0,75	0,8889	1,7778	3,5556	2,2804
0,77	0,8433	1,6866	3,3732	2,5206
0,79	0,8012	1,6023	3,2046	2,8564
0,81	0,7621	1,5242	3,0483	3,3592
0,83	0,7258	1,4516	2,9032	4,1954
0,85	0,6920	1,3841	2,7682	5,8612
0,87	0,6606	1,3212	2,6424	10,8086
0,89	0,6312	1,2625	2,5249	677,6515
0,91	0,6038	1,2076	2,4152	-9,4293
0,93	0,5781	1,1562	2,3124	-4,2550
0,95	0,5540	1,1080	2,2161	-2,5473
0,97	0,5314	1,0628	2,1256	-1,6965

0,99	0,5102	1,0203	2,0406	-1,1869
1,01	0,4901	0,9803	1,9606	-0,8475
1,03	0,4713	0,9426	1,8852	-0,6052
1,05	0,4535	0,9070	1,8141	-0,4235
1,07	0,4367	0,8734	1,7469	-0,2822
1,09	0,4208	0,8417	1,6834	-0,1691
1,11	0,4058	0,8116	1,6232	-0,0766
1,13	0,3916	0,7831	1,5663	0,0006
1,15	0,3781	0,7561	1,5123	0,0658
1,17	0,3653	0,7305	1,4610	0,1218
1,19	0,3531	0,7062	1,4123	0,1704
1,21	0,3415	0,6830	1,3660	0,2129
1,23	0,3305	0,6610	1,3220	0,2504
1,25	0,3200	0,6400	1,2800	0,2838
1,27	0,3100	0,6200	1,2400	0,3137
1,29	0,3005	0,6009	1,2018	0,3406
1,31	0,2914	0,5827	1,1654	0,3649
1,33	0,2827	0,5653	1,1306	0,3871
1,35	0,2743	0,5487	1,0974	0,4074
1,37	0,2664	0,5328	1,0656	0,4259
1,39	0,2588	0,5176	1,0351	0,4430
1,41	0,2515	0,5030	1,0060	0,4589
1,43	0,2445	0,4890	0,9780	0,4735
1,45	0,2378	0,4756	0,9512	0,4871
1,47	0,2314	0,4628	0,9255	0,4998
1,49	0,2252	0,4504	0,9009	0,5117
1,51	0,2193	0,4386	0,8772	0,5228
1,53	0,2136	0,4272	0,8544	0,5332
1,55	0,2081	0,4162	0,8325	0,5430
1,57	0,2028	0,4057	0,8114	0,5522
1,59	0,1978	0,3956	0,7911	0,5609
1,61	0,1929	0,3858	0,7716	0,5691
1,63	0,1882	0,3764	0,7528	0,5769
1,65	0,1837	0,3673	0,7346	0,5843
1,67	0,1793	0,3586	0,7171	0,5913
1,69	0,1751	0,3501	0,7003	0,5980
1,71	0,1710	0,3420	0,6840	0,6044
1,73	0,1671	0,3341	0,6682	0,6104
1,75	0,1633	0,3265	0,6531	0,6162
1,77	0,1596	0,3192	0,6384	0,6217
1,79	0,1561	0,3121	0,6242	0,6270
1,81	0,1526	0,3052	0,6105	0,6321
1,83	0,1493	0,2986	0,5972	0,6369
1,85	0,1461	0,2922	0,5844	0,6416
1,87	0,1430	0,2860	0,5719	0,6461
1,89	0,1400	0,2799	0,5599	0,6504
1,91	0,1371	0,2741	0,5482	0,6545
1,93	0,1342	0,2685	0,5369	0,6585
1,95	0,1315	0,2630	0,5260	0,6623
1,97	0,1288	0,2577	0,5153	0,6660
1,99	0,1263	0,2525	0,5050	0,6696
2,01	0,1238	0,2475	0,4950	0,6730
2,03	0,1213	0,2427	0,4853	0,6763
2,05	0,1190	0,2380	0,4759	0,6795

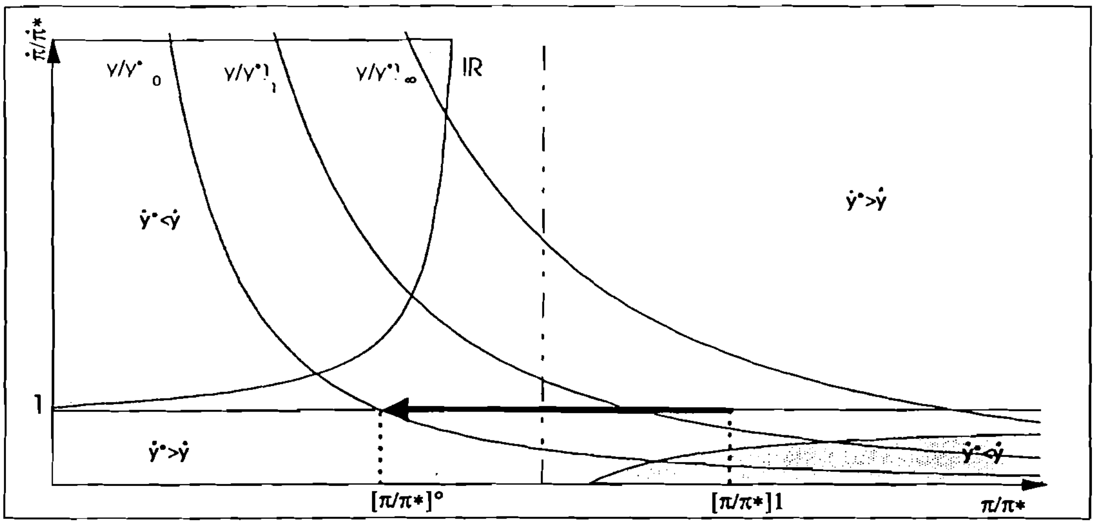

Figure ., Dynamics of comparative (Dis) Advantages and Convercence
vs Divergence in the Gorwth rate differential

Figure .				
α =	0.5			
γ=	0.5			
δ =	0.5			
π* =	1			
C =	4			
η* =	1			
ψ =	0.4			
β =	0.53			
η =	1.1			
	y/y*)o	y/y*)1	y/y*)	IR
π/π*	1.00E-06	1	1000000	
0.05	200.0003	400.0000	799.9988	0.9597
0.07	102.0410	204.0816	408.1627	0.9510
0.09	61.7285	123.4568	246.9132	0.9429
0.11	41.3224	82.6446	165.2890	0.9350
0.13	29.5858	59.1716	118.3430	0.9273
0.15	22.2223	44.4444	88.8888	0.9195
0.17	17.3011	34.6021	69.2040	0.9118
0.19	13.8504	27.7008	55.4016	0.9039
0.21	11.3379	22.6757	45.3514	0.8959
0.23	9.4518	18.9036	37.8071	0.8877
0.25	8.0000	16.0000	32.0000	0.8793
0.27	6.8587	13.7174	27.4348	0.8706
0.29	5.9453	11.8906	23.7812	0.8617
0.31	5.2029	10.4058	20.8116	0.8524
0.33	4.5914	9.1827	18.3654	0.8428
0.35	4.0816	8.1633	16.3265	0.8328
0.37	3.6523	7.3046	14.6092	0.8223
0.39	3.2873	6.5746	13.1492	0.8114
0.41	2.9744	5.9488	11.8977	0.8000
0.43	2.7042	5.4083	10.8166	0.7880
0.45	2.4691	4.9383	9.8765	0.7754
0.47	2.2635	4.5269	9.0539	0.7621
0.49	2.0825	4.1649	8.3299	0.7480
0.51	1.9223	3.8447	7.6893	0.7331
0.53	1.7800	3.5600	7.1200	0.7172
0.55	1.6529	3.3058	6.6116	0.7003
0.57	1.5389	3.0779	6.1557	0.6823
0.59	1.4364	2.8727	5.7455	0.6630
0.61	1.3437	2.6874	5.3749	0.6423
0.63	1.2598	2.5195	5.0390	0.6201
0.65	1.1834	2.3669	4.7337	0.5960
0.67	1.1138	2.2277	4.4553	0.5698
0.69	1.0502	2.1004	4.2008	0.5414
0.71	0.9919	1.9837	3.9675	0.5103
0.73	0.9383	1.8765	3.7530	0.4762
0.75	0.8889	1.7778	3.5556	0.4385
0.77	0.8433	1.6866	3.3732	0.3967
0.79	0.8012	1.6023	3.2046	0.3501
0.81	0.7621	1.5242	3.0483	0.2977
0.83	0.7258	1.4516	2.9032	0.2384
0.85	0.6920	1.3841	2.7682	0.1706
0.87	0.6606	1.3212	2.6424	0.0925
0.89	0.6312	1.2625	2.5249	0.0015
0.91	0.6038	1.2076	2.4152	-0.1061
0.93	0.5781	1.1562	2.3124	-0.2350
0.95	0.5540	1.1080	2.2161	-0.3926
0.97	0.5314	1.0628	2.1256	-0.5895

0,99	0,5102	1,0203	2,0406	-0,8425
1,01	0,4901	0,9803	1,9606	-1,1800
1,03	0,4713	0,9426	1,8852	-1,6525
1,05	0,4535	0,9070	1,8141	-2,3615
1,07	0,4367	0,8734	1,7469	-3,5442
1,09	0,4208	0,8417	1,6834	-5,9139
1,11	0,4058	0,8116	1,6232	-13,0604
1,13	0,3916	0,7831	1,5663	########
1,15	0,3781	0,7561	1,5123	15,1868
1,17	0,3653	0,7305	1,4610	8,2081
1,19	0,3531	0,7062	1,4123	5,8694
1,21	0,3415	0,6830	1,3660	4,6976
1,23	0,3305	0,6610	1,3220	3,9937
1,25	0,3200	0,6400	1,2800	3,5240
1,27	0,3100	0,6200	1,2400	3,1882
1,29	0,3005	0,6009	1,2018	2,9363
1,31	0,2914	0,5827	1,1654	2,7403
1,33	0,2827	0,5653	1,1306	2,5833
1,35	0,2743	0,5487	1,0974	2,4549
1,37	0,2664	0,5328	1,0656	2,3478
1,39	0,2588	0,5176	1,0351	2,2571
1,41	0,2515	0,5030	1,0060	2,1793
1,43	0,2445	0,4890	0,9780	2,1119
1,45	0,2378	0,4756	0,9512	2,0529
1,47	0,2314	0,4628	0,9255	2,0008
1,49	0,2252	0,4504	0,9009	1,9544
1,51	0,2193	0,4386	0,8772	1,9129
1,53	0,2136	0,4272	0,8544	1,8756
1,55	0,2081	0,4162	0,8325	1,8417
1,57	0,2028	0,4057	0,8114	1,8110
1,59	0,1978	0,3956	0,7911	1,7829
1,61	0,1929	0,3858	0,7716	1,7571
1,63	0,1882	0,3764	0,7528	1,7333
1,65	0,1837	0,3673	0,7346	1,7114
1,67	0,1793	0,3586	0,7171	1,6911
1,69	0,1751	0,3501	0,7003	1,6722
1,71	0,1710	0,3420	0,6840	1,6546
1,73	0,1671	0,3341	0,6682	1,6382
1,75	0,1633	0,3265	0,6531	1,6228
1,77	0,1596	0,3192	0,6384	1,6084
1,79	0,1561	0,3121	0,6242	1,5948
1,81	0,1526	0,3052	0,6105	1,5821
1,83	0,1493	0,2986	0,5972	1,5700
1,85	0,1461	0,2922	0,5844	1,5586
1,87	0,1430	0,2860	0,5719	1,5478
1,89	0,1400	0,2799	0,5599	1,5376
1,91	0,1371	0,2741	0,5482	1,5279
1,93	0,1342	0,2685	0,5369	1,5187
1,95	0,1315	0,2630	0,5260	1,5099
1,97	0,1288	0,2577	0,5153	1,5015
1,99	0,1263	0,2525	0,5050	1,4935
2,01	0,1238	0,2475	0,4950	1,4859
2,03	0,1213	0,2427	0,4853	1,4786
2,05	0,1190	0,2380	0,4759	1,4716

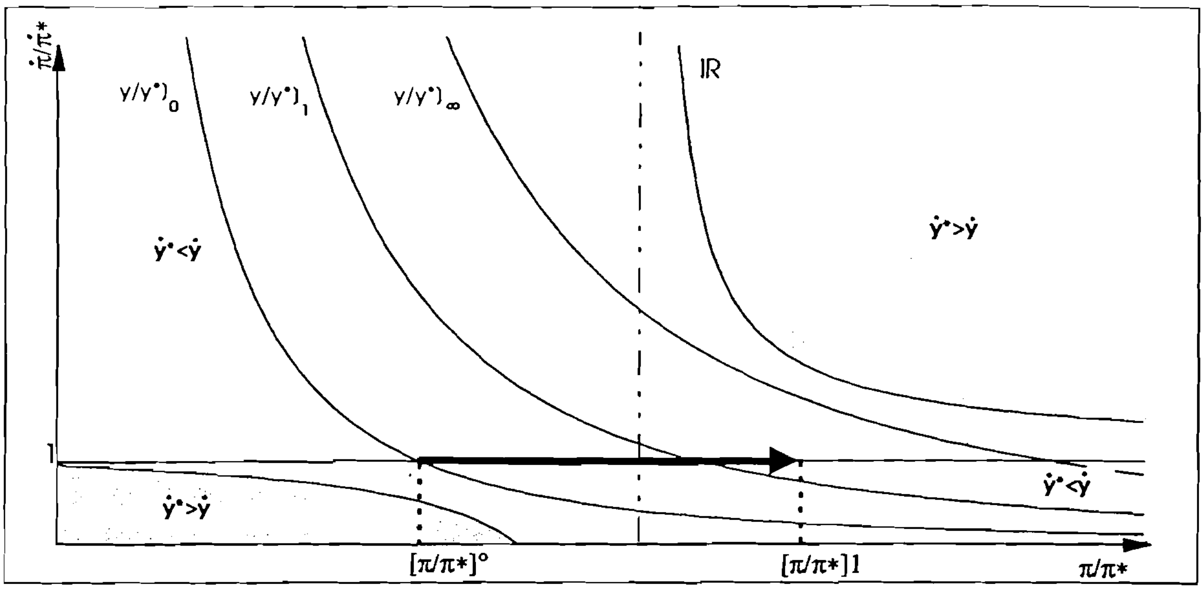

Figure , Dynamics of comparative (Dis) Advantages and Convercence vs Divergence in the Gorwth rate differential

	z	Z= f(ψ)			y/y*
π/π*	ψ= 0,4	0,2	0,6	0,8	
0,05	16,4166	4,05174	66,51579	269,5047	
0,07	14,34934	3,788052	54,35606	205,9036	
0,09	12,977	3,60236	46,74781	168,4024	
0,11	11,97606	3,460645	41,4449	143,4261	
0,13	11,20196	3,346932	37,49218	125,4838	
0,15	10,57876	3,2525	34,40741	111,9101	
0,17	10,06217	3,172092	31,91813	101,2472	
0,19	9,624313	3,102308	29,85758	92,6274	
0,21	9,246629	3,040827	28,1174	85,50016	
0,23	8,916205	2,986001	26,6238	79,49871	
0,25	8,62373	2,936619	25,32461	74,36872	
0,27	8,362298	2,891764	24,18179	69,92804	
0,29	8,126658	2,850729	23,1669	66,04257	
0,31	7,912733	2,812958	22,25818	62,61134	
0,33	7,717304	2,778004	21,4387	59,55678	
0,35	7,537789	2,745503	20,69502	56,81826	
0,37	7,372088	2,715159	20,01639	54,34767	
0,39	7,218473	2,686722	19,39403	52,10635	
0,41	7,075508	2,659983	18,82073	50,06281	
0,43	6,941987	2,634765	18,2905	48,19118	
0,45	6,816888	2,610917	17,79833	46,46996	
0,47	6,69934	2,588308	17,33996	44,88116	
0,49	6,588594	2,566826	16,91177	43,40957	
0,51	6,484001	2,54637	16,51067	42,04227	
0,53	6,384999	2,526856	16,13397	40,76821	
0,55	6,291093	2,508205	15,77935	39,57785	
0,57	6,20185	2,490351	15,44478	38,46294	
0,59	6,116886	2,473234	15,12849	37,41629	
0,61	6,035861	2,456799	14,8289	36,43162	
0,63	5,958473	2,440998	14,54462	35,5034	
0,65	5,884449	2,425788	14,27443	34,62674	
0,67	5,813548	2,41113	14,01722	33,79734	
0,69	5,745549	2,396987	13,77201	33,01133	
0,71	5,680255	2,383329	13,53791	32,2653	
0,73	5,617486	2,370124	13,31414	31,55615	
0,75	5,55708	2,357346	13,09996	30,88114	
0,77	5,498888	2,344971	12,89473	30,23777	
0,79	5,442774	2,332975	12,69786	29,62379	
0,81	5,388615	2,321339	12,5088	29,03717	
0,83	5,336296	2,310042	12,32707	28,47606	0,001489
0,85	5,285713	2,299068	12,15221	27,93876	0,00428
0,87	5,23677	2,288399	11,98382	27,42376	0,007031
0,89	5,189376	2,27802	11,8215	26,92963	0,009741
0,91	5,143451	2,267918	11,66492	26,45509	0,012412
0,93	5,098918	2,258078	11,51376	25,99896	0,015047
0,95	5,055705	2,24849	11,3677	25,56015	0,017645
0,97	5,013748	2,23914	11,22648	25,13767	0,020209
0,99	4,972984	2,230019	11,08985	24,73057	0,022739
1,01	4,933358	2,221116	10,95756	24,33802	0,025237
1,03	4,894815	2,212423	10,8294	23,95921	0,027704

1,05	4,857306	2,20393	10,70516	23,59342	0,030141
1,07	4,820784	2,195628	10,58465	23,23996	0,032548
1,09	4,785205	2,187511	10,46769	22,89819	0,034927
1,11	4,750529	2,179571	10,35411	22,56753	0,037278
1,13	4,716717	2,1718	10,24377	22,24742	0,039603
1,15	4,683732	2,164193	10,1365	21,93735	0,041901
1,17	4,651541	2,156743	10,03218	21,63683	0,044174
1,19	4,620111	2,149444	9,930671	21,34542	0,046423
1,21	4,589412	2,142291	9,831857	21,0627	0,048648
1,23	4,559415	2,135279	9,735622	20,78827	0,05085
1,25	4,530094	2,128402	9,641858	20,52175	0,05303
1,27	4,501422	2,121655	9,550465	20,2628	0,055187
1,29	4,473375	2,115035	9,461346	20,01108	0,057323
1,31	4,44593	2,108537	9,374411	19,7663	0,059439
1,33	4,419066	2,102158	9,289573	19,52815	0,061534
1,35	4,392762	2,095892	9,206753	19,29636	0,063609
1,37	4,366998	2,089736	9,125873	19,07067	0,065665
1,39	4,341754	2,083688	9,04686	18,85083	0,067702
1,41	4,317015	2,077743	8,969646	18,63662	0,069721
1,43	4,292761	2,071898	8,894164	18,4278	0,071722
1,45	4,268979	2,066151	8,820353	18,22418	
1,47	4,24565	2,060498	8,748153	18,02555	
1,49	4,222763	2,054936	8,677507	17,83172	
1,51	4,200301	2,049464	8,608363	17,64253	
1,53	4,178252	2,044077	8,540669	17,45779	
1,55	4,156602	2,038775	8,474376	17,27734	
1,57	4,135341	2,033554	8,409438	17,10104	
1,59	4,114455	2,028412	8,34581	16,92874	
1,61	4,093934	2,023347	8,28345	16,76029	
1,63	4,073766	2,018357	8,222317	16,59557	
1,65	4,053943	2,01344	8,162372	16,43445	
1,67	4,034452	2,008595	8,103579	16,27681	
1,69	4,015286	2,003818	8,045902	16,12252	
1,71	3,996435	1,999108	7,989307	15,97149	
1,73	3,97789	1,994465	7,933761	15,82361	
1,75	3,959642	1,989885	7,879233	15,67877	
1,77	3,941685	1,985368	7,825693	15,53688	
1,79	3,924009	1,980911	7,773112	15,39784	
1,81	3,906607	1,976514	7,721463	15,26158	
1,83	3,889473	1,972175	7,67072	15,128	
1,85	3,872599	1,967892	7,620855	14,99702	
1,87	3,855978	1,963664	7,571846	14,86857	
1,89	3,839604	1,959491	7,523669	14,74256	
1,91	3,823471	1,95537	7,4763	14,61893	
1,93	3,807573	1,9513	7,429719	14,49761	
1,95	3,791904	1,947281	7,383903	14,37854	
1,97	3,776458	1,943311	7,338833	14,26164	
1,99	3,76123	1,939389	7,29449	14,14685	
2,01	3,746215	1,935514	7,250853	14,03413	
2,03	3,731408	1,931685	7,207906	13,92341	
2,05	3,716804	1,927901	7,165631	13,81463	

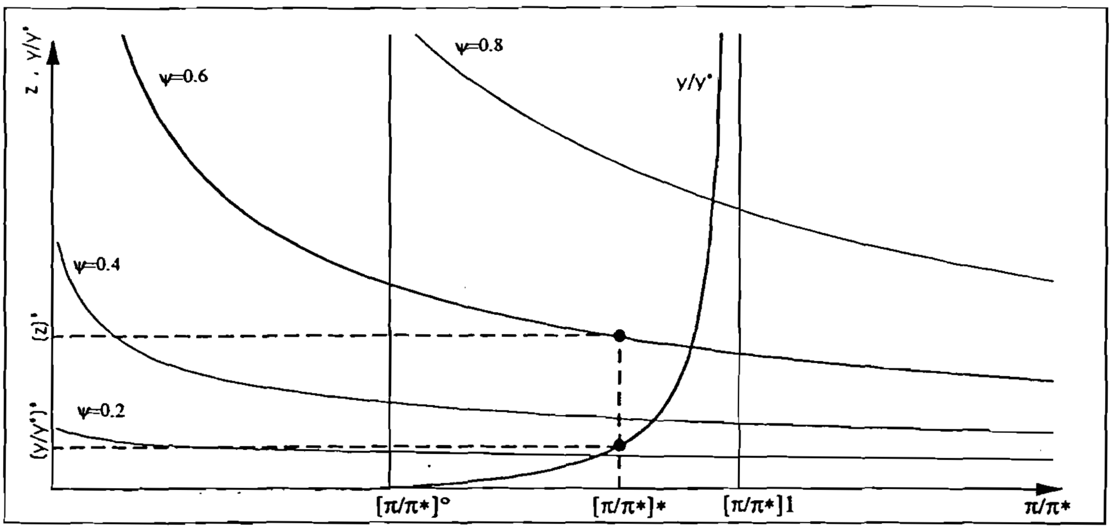

Figure , A solution for the model : specialization and output

References

Aboites J (1988), "Regimen de Acumulacion, Relacion Salarial y Crisis en Mexico", paper presented at the Conference on the Theory of Regulation Barcelona, June 1988.

Amable B. (1992), "Effects d'apprentissage, compétitivité hors-prix et croissance cumulative", *Economie Appliquée*, 45, n.3, 5-31.

Amable B. (1993), "National effects of learning, international specialization and growth paths", in D. Foray and C. Freeman (eds) *Technology and the Wealth of Nations*, Pinter Publishers, London.

Beelen E. and B. Verspagen (1993), "The role of convergence in trade and sectoral growth", paper presented at the Conference on *Catching up, Forging Ahead and Falling Behind*, 14-16 May, Oslo.

Boyer R. (1988a), "Technical Change and the Theory of Regulation",in G. Dosi, C. Freeman, R. Nelson and L. Soete (eds), *Technical Change and Economic Theory*, Frances Pinter, London.

Boyer R. (1988b), "Formalizing Growth Regimes Within a Regulation Approach", in G. Dosi, C. Freeman, R. Nelson and L. Soete (eds), *Technical Change and Economic Theory*, Frances Pinter, London.

Canter U. and H. Hanusch (1990), "Process and Product Innovation in an International Trade Context", presented at the EAEPE-Conference in Florence, ((1992), *Economics of Innovation and New Technology*, (forthcoming)

Cimoli, M., G. Dosi and L. Soete (1986), Innovation Diffusion Institutional Differences and Patterns of Trade: A North-South Model, Brighton, SPRU, *University of Sussex, DRC Discussion Paper n. 34.*

Cimoli M. (1988), "Technological Gaps and Institutional Asymmetries in a North-South Model with a Continuum of Goods", *Metroeconomica*, 39, 245-274.

Cimoli M. (1991), "Innovation, Endogenous Comparative Advantages and Long-Run Growth", *Nota di lavoro* n. 8808, Dipartimento di economia, Universita' di Venezia.

Cimoli M. and L. Soete (1992), "A Generalized Technological Gap Trade Model", *Economie Appliquée*, 45, n.3, 33-54.

Collins S. (1985), "Technical Progress in a Three-Country Ricardian Model with a Continuum of Goods", *Journal of International Economics*, 19, 171-179.

Coriat B. and J. Saboia (1987), "Regime D'Accumulation et Rapport Salarial au Bresil (des années 1950 au années 1980)", mimeo.

Cornwall J. (1977), *Modern Capitalism: Its Growth and Transformation*, Martin Roberston, London.

David L. (1988), *Technology Intensity of U. S., Canadian and Japanese Manufactures Output and Exports*, U.S. Department of Commerce International Trade Administration.

Dixon R. and A. Thirlwall (1975), "A Model of Regional Growth-Rate Differences on Kaldorian Lines", *Oxford Economic Paper*, 11, 1120-1171.

Dosi G. and L. Soete (1983), "Technological Gaps and Cost-based Adjustments: Some Explorations on the Determinants of International Competitiveness", *Metroeconomica*, 12, 357-382.

Dosi G. and L.Soete (1988), Technical Change and International Trade, in G. Dosi , C. Freeman, R. Nelson, G. Silverberg and L. Soete (eds), *Technical Change and Economic Theory*, Pinter Publishers, London.

Dosi, G., K. Pavitt and L. Soete (1990), *The Economics of Technical Change and International Trade*, Harvester Wheatsheaf, Brighton.

Dosi G. and C. Freeman (1992), "The Diversity of Development Patterns: On the Processes of Catching-up, Forging Ahead and Falling Behind", paper presented at the Conference on *Economic Growth and the Structure of Long-term Development*, Varenna 1-3 Ottobre.

Dornbusch, R.S., Fischer and P. Samuelson (1977), "Comparative Advantage, Trade and Payments in a Ricardian Model with a Continuum of Goods", *American Economic Review*, 67, 823-839.

Dollar, D. (1986), Technological Innovation, Capital Mobility, and the Product Cycle in North-South trade, *American Economic Review.*

Fagerberg J. (1988), "Why growth rates differ", in G. Dosi, C. Freeman, R. Nelson and L. Soete (eds), *Technical Change and Economic Theory*, Frances Pinter, London.

Fagerberg J. (1993), "The Role of Technology in Why Growth Rates Differ: An Overview", paper presented at the Conference on *Catching up, Forging Ahead and Falling Behind*, 14-16 May, Oslo.

Freeman, C. (1963), The Plastic Industry: a Comparative Study of Research and Innovation, *National Institute Economic Review*, n.26.

Freeman, C. (1965), Research and Development in Electronic Capital goods, *National Institute Economic Review*, n.34.

Gomulka S. (1971), *Inventive Activity, Diffusion and the Stages of Economic Growth,* Aarthus, Skrifter fra Aarthus Universtets Okonomiske Institut, 24.

Hirsch. S. (1965), The US electronics industry in international trade, *National Institute Economic Rewiew*, n. 34.

Hufbauer (1966), *Synthetic Materials and the Theory of International Trade*, London, Buckworth.

Kaldor N. (1975), What is wrong with Economic Theory?, *Quarterly Journal of Economics*, August.

Kaldor N. (1966), "Causes of the Slow Rate of economic Growth in the United Kingdom", *Cambridge University Press*, Cambridge.

Kaldor N. (1975), "What is Wrong with the Economic Theory?", *Quarterly Journal of Economics*, 89, 347-357.

Kennedy C. and Thirlwall A. (1979), "Import Penetration, Export Performance and Harrod's Trade Multiplier", *Oxford Economic Papers*, 31, 303-322.

Krugman, P. (1979), A Model of Innovation, Technology Transfer and the World Distribution of Income, *Journal of Political Economy*, Vol. 87.

Metcalfe S. (1989), "Trade, Technology and Evolutionary Change", in R. Harrington et al. (eds), *Money, Trade and Payments*, MIT Press.

Metcalfe, S. and L. Soete (1984), Notes on the Evolution of Technology and International Competition, in M. Gibbons et Al (eds)., *Science and Technology Policy in the 1980's and Beyond*, Longman, London.

Pavitt K. and P. Patel (1988), "The International Distribution and Determinants of Technological Activities", *Oxford Economic Paper*, 4.

Posner, M.V. (1961), International Trade and Technological Change, *Oxford Economic Paper*, Vol. 13.

Reinert E. (1993), "Catching up from Far Behind. A Third World Perspective on the First World History, paper presented at the Conference on *Catching up, Forging Ahead and Falling Behind*, 14-16 May, Oslo.

Soete L. (1985), Innovation and International Trade, in B. Williams and J. Bryan-Brown (eds) *Knows ans Unknowns in Technical Change*, Technical Change Centre , London.

Soete L. (1987), "The Impact of Technological Innovation on International Trade patterns: The Evidence Reconsidered", *Research Policy*, 16, 101-130.

Soete L. and B. Verspagen (1992), "Competing for Growth: the Dynamics of Technology Gaps. Convergence and Imovation", paper presented at the Conference on *Economic Growth and the Structure of Long-term Development*, Varenna 1-3 Octobre.

Thirlwall A. (1979), The Balance of Payments Constraint as an Explanation of international Growth Rate differences, *Banca Nazionale* *del Lavoro Quarterly Review*, March.

Thirlwall A. (1980), "*Balance of Payment Theory and the United Kingdom Experience*, Macmillan, London.

Thirlwall A. (1982), "The Harrod Trade Multiplier and the Importance of Export-Led Growth", *Pakistan Journal Of Applied Economics*, 1, 1-21.

Thirwall A. and Dixon R. (1979), "A model of Export-led Growth with Balance of Payments Constraint", in J. Bowers (ed.), *Inflation, Development and Integration*, Leeds University Press.

Thirlwall A. and Hussain M.N. (1982), "The balance of payments constraint, capital flows and growth rate differences between developing countries", *Oxford Economic Papers*, 34, 498-510.

Vaglio A. (1988), "Statics and Dynamic Economies of Scale in Export-led growth", *Economics Notes*, 2, 61-81.

Vernon, R. (1966), International Investment ad International Trade in the Product Cycle, *Quarterly Journal of Economics*, Vol. 80.

Verspagen B. (1990), "Catching Up or Falling Behind? A Dynamic Model of Growth Rate Differential", *Merit Research Memorandum*, 90-004, MERIT.

Verspagen B. (1991), "Technology, Specialization patterns and Growth Rate Differential: A Multi-Sector Evolutionary Model of Balance of Payments Restricted Growth", *Merit research Memorandum*, 91-007, MERIT.

Wilson, C.A. (1980), "On General Structure of Ricardian Models with a Continuum of Goods: Applications to Growth, Tariff Theory and Technical change", *Econometrica*, 48, 1675-1702.