ECONOMIC GROWTH AND STRUCTURAL CHANGE: A POSSIBLE EXPLANATION OF THE LONG WAVE

C.W.A.M. van Paridon

September 1985
WP-85-58

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
2361 Laxenburg, Austria

FOREWORD

Many of today's most significant socioeconomic problems, such as slower economic growth, the decline of some established industries, and shifts in patterns of foreign trade, are inter- or transnational in nature. Intercountry comparative analyses of recent historical developments are necessary when we attempt to identify the underlying processes of economic structural change and formulate useful hypotheses concerning future developments. The understanding of these processes and future prospects provides the focus for IIASA's project on Comparative Analysis of Economic Structure and Growth.

To understand these economic processes completely however, an identification of the role played by dynamic processes of long duration is also needed. In many economic issues it is imperative to ascertain the parts played by structural and cyclical causes. Such events are studied in so-called long-waves theories which for almost a century have fascinated not only economists. To date there are several long-waves theories that try to explain these causes with varying degrees of success. However, the spectrum of views on the long-wave phenomenon is very wide, including those who question their existence altogether. Nevertheless, the consensus seems to be that the long-wave phenomenon may help in understanding complex economic processes.

This study by C.W.A.M. van Paridon is an illustration of the numerous and various intricate processes one has to consider when trying to explain long-wave behavior. This work was in part prepared during the author's stay at IIASA as a winner of the Peccei Fellowship Award and draws on his previous work on structural change and foreign trade.

Anatoli Smyshlyaev
Project Leader
Comparative Analysis of
Economic Structure and Growth

Tibor Vasko
Leader
Clearninghouse Activities

ECONOMIC GROWTH AND STRUCTURAL CHANGE: A POSSIBLE EXPLANATION OF THE LONG WAVE

C.W.A.M. van Paridon

1. INTRODUCTION

1984 became a year in which important questions were posed, and not only because of the Orwellian context. In economics heavy discussion arose as to whether 1984 was the first year of a new, long wave upswing or just another year in the more prosperous phase of the normal business cycle in a still continuing, long wave downward movement. The problem was clearly expressed in the opening sentence of the *Economic Outlook* of the OECD (July 1984): "With the OECD economy, and most economies individually, now well into recovery, crucial questions are how strong, and how durable, the recovery will prove to be" (OECD, 1984, p. 15). How pregnant these questions were became clear when the OECD projections for the next year were taken into account. Real GNP for the OECD area rose from 2.4% in 1983 to 4.5% in 1984, but for 1985 a slowdown was expected to 2.7%. Two other important variables, the rate of inflation and the unemployment rate, showed only a very slight improvement in this projection.

It cannot be said that economic scientists and economic policymakers have treated the current economic depression in the most optimal way. Too often, a rather short-term view has been held and short-term solutions proposed, while it became more and more clear that long-term developments had to be analyzed, and also that only in the longer term could a real improvement of the economic situation be expected. The question arises: "Why was there this short-sightedness?"

Two reasons can be given. On the one hand, political decision-making has been nearly always directed at short-term results because of electoral motives. Politicians want to see immediate results of their policy proposals and are less demanding for longer term improvements. This short-term attitude in the economic area was especially strengthened in the post World War II period, because of the introduction of mostly Keynesian inspired models, very usable for short-term forecasts. And since most of the time these forecasts have been confirmed by reality, it is not so strange that this attitude prevailed.

However, and this is the other side of the story, economists have not given sufficient warning of the possible danger or, even worse, they have not themselves realized well-enough the possibility that at some moment these models would fail. Each model was constructed on the assumption that the basic, underlying structure of an economy would not change in the short term. By the basic, underlying structure I mean:

(1) The structure of consumption and production.

(2) A constancy in the behavior of all the relevant actors in the economic process – consumers, producers, investors – on the various markets.

As long as this basic economic structure did not change, the models predicted very well. However, in the longer term, (1) gradually changed and, as soon as the stagnation started, (2) changed drastically. Immediately, the models were no longer

able to trace the economic developments in a reasonable way.

The neglect of this change in the basic structure of the economy also occurred with regard to the theory of economic growth, another main branch of research in the 1960s that was directed at an explanation of long-term developments. The mistake not to account for changes in the basic structure of the economy was a major determinant in the theory's failure at the end of the 1970s.

Although economic science has lost much of its status in recent years, it must be said in favor of it that some changes did occur in its research program as soon as it became clear that the old approaches failed to fully account for the changed circumstances. One of the most promising new approaches has been that of long wave research.

Since 1975, renewed attention has been paid to that old, nearly forgotten, and sometimes ridiculed aspect of economic science. Culminating in Schumpeter's *Business Cycles*, research on long waves had been very important in the 1930s. Van Gelderen, de Wolff, Kondratieff, and Schumpeter, among others, had tried to prove the existence of such a long wave and to describe a possible theoretical explanation of it. After World War II, long wave theory was dropped from sight. The first signs, however, of a new economic crisis revived interest. Since then, a remarkable growth has appeared in this area; witness the still increasing stream of publications and conferences on this subject.[1] Without any doubt, research has deepened our insights into the causes of the present economic depression and, more generally, into the longer term development of industrialized economies. But it is also clear that a theory with the definitive answer is still lacking. In this working paper I propose some, in my view, indispensable, materials for such a theory.

Partly based on some of my earlier publications, published in Dutch,[2] and partly based on ongoing research for my doctoral thesis, I present here a possible explanation of the phenomenon of the long wave. In this outline developments in and between *(a)* economic growth, *(b)* transformation of the economic structure, and *(c)* international economic relationships, are important elements.

To make my position in the area of long waves a bit more clear, I start with a brief survey on recent developments in long wave research. Thereafter, I describe my view of long wave economic development. Finally, I return to the problems raised in the Introduction as to the position the industrialized countries find themselves with regard to the long wave at this moment. On the basis of the presented outline, I try to give some preliminary answers. In this respect, I also broaden the discussion by presenting some thoughts on the economic and social consequences of some possible choices with regard to a (desired) future economic development.

2. Research on Long Waves: An Overview

Normally, to present a survey of a particular research area is one of the more difficult tasks. All the different opinions have to be taken into account and valued. Even more difficult is to survey an area in which the opinions are not yet fully crystallized and in which new opinions are still appearing at the time of writing. However, for the case of long wave research, several authors[3] have recently completed this task in a way that is difficult to improve upon. I have decided to use one of these surveys, namely the most recent by Delbeke (1984), as a framework for this section.[4] Delbeke classifies long wave research in three different ways; first, on the basis of an inductive or a deductive approach; second, on the basis of the main explanatory determinant; and, third, on the methodology chosen.

As in the normal process of science, first the more inductive phase had to occur. Research in this phase was directed at identifying particular long wave developments in several kinds of variables, real as well as monetary, and at trying to prove the (non)existence of this kind of wave. It cannot be said that this kind of research has yet achieved clear-cut answers. The conclusions have ranged from full acceptance of a wave with a fixed regularity to outright rejection of any wave-like concept at all, especially for real variables such as industrial output or GNP. Several reasons can be given for the existence of this confusing situation. First, several very different methods – descriptive, historiographic, empirico-inductive – were used in the formulation of tentative hypotheses and assumptions, tentative because no firm body of deductive research was yet available. Second, a necessary requirement for any inductive research could not be met sufficiently, namely the availability of qualitative, accurate data on a sufficient number of economic and noneconomic variables over a sufficiently long period. And third, and certainly not the least important, scepticism about the long wave concept also arose because of severe criticism of the applied statistical procedures. In spite of all these correct reservations, and of all the differences of opinion on the existence of long waves, I am inclined to support the view that the industrialized economies have shown, after their respective take-off phases, a wave-like development in their real and monetary variables, with a duration of between 40 and 60 years.[5] Specific circumstances and developments, different in different periods, strongly influence the length of each wave, especially in the downward phase.

The absolute answer as to the existence of long waves cannot be given in the very near future, since, for instance, time-series over a sufficiently long period are still scarce. Also, since waiting for another 100 years cannot be seen as a reasonable option, recently most research on long waves has been directed at an explanation of the long wave and at the underlying causal mechanisms. Delbeke (1984) used two kind of classifications in analyzing the several more deductive approaches.[6] One classification is based upon the main explanatory determinant, the other on the methodology chosen. With respect to the first kind of classification, Delbeke distinguished between real, monetary, and institutional theories, of which the real theories have attracted most attention recently. In contrast with the earlier periods of flourishing long wave research, monetary theories are now pushed to the background. One of the main reasons for this decline in the importance of monetary theories is that, after World War II prices have only increased and have not declined, as would be expected from historical patterns. Institutional theories have increased in relative importance.

In the several *real theories*, Delbeke saw a common basic pattern, namely that the authors tried to explain the alternation of periods of shortage and abundance of a production factor or input. As production factors or inputs, he listed, according to the different theories, capital, labor, raw materials, and entrepreneurship.[7] At the lower turning point the relevant production factor shows an abundant supply with a relatively low price. During the upswing it becomes scarcer, resultant with rising prices, in this way contributing to the lowering of profitability of the production process. Another factor for the decline in profits is the lack of a sufficient income redistribution, hindered as it is by social and institutional inertia. Only after a particular period when these inertia are removed and income redistribution has succeeded, does the scarcity of the factor decline and its relative price decrease.

The second group of theories, the *monetary oriented*, has shown a decline in importance, although most authors on long wave theories would agree with the statement that price formation, interest rates, credit, and money circulation are essential elements. Delbeke states that these elements are neglected too much in

recent theories.[8]

The same remark does not apply to the third group, that of *social and institutional theories*. The authors of these theories consider a pure economic analysis as too narrow, and propose an approach in which the whole system and the interactions between social, institutional, technological, and economic subsystems are taken into account. Also, research on market behavior falls into this category.[9]

Delbeke concluded that although the several theories emphasized different aspects of the long wave movement and although they had different starting points and assumptions, they were more complementary than is normally suggested. According to him, a fruitful approach to the phenomenon of the long wave is not possible if all the three main branches of theories, real, monetary, and institutional, are not integrated. He therefore preferred, along with Van Duijn and other authors, an eclectic approach, because such a complex phenomenon as the long wave could not be reasonably explained in a monocausal way.[10]

The second classification is based on several methodologies developed to analyze long waves. Delbeke distinguished between the historical–institutional approach, the growth theoretical approach, the macroeconomic approach, and the analysis of noneconomic variables.

In the *historical–institutional approach*, each wave is seen as a unique event. Any deterministic interpretation of history is rejected. These authors stress the point that the start of an upward phase of a long wave is dependent on the rapid diffusion of a new, important technology – microelectronics and the related communication-oriented technologies in 1985, for instance. This diffusion, however, is initially hindered by the lack of accompanying institutional innovations, on both a national and international level. Each wave is then characterized by a particular match of technological and of social and institutional innovations. Once in the upward phase, the possibilities of the new technology are explored to the end (along a technoeconomic paradigm). Coming close to exhaustion, the growth process slows down, passing into the downward phase. A new group of technologies has to emerge, involving not only technical innovations, but also new managerial and organizational principles, to change the economic development once again in the positive direction.[11] On the whole the analysis of this approach is rather verbal. Authors like Freeman and Perez-Perez show in their way of analysis a certain resemblance to Schumpeter, stressing the need of a qualitative dimension in the long wave debate.

Conversely, the other approaches have a much stronger mathematical/statistical background. In the *growth–theoretical approach*, nonlinear dynamic models are used to study the emergence of new configurations from structural instability. Mensch, taken as the most important representative of this group, uses a metamorphosis model of long-term industrial innovation, showing that four phases can be discerned by the mix of innovation types, basic/improvement, and product/process. Inventions are assumed to be made randomly over time. Transformation into a basic innovation takes time and is strongly dependent on the state of the economy, i.e., the old technologies must approach their level of saturation. If the conditions are favorable, then many of the accumulated inventions may be turned into practical applications within a relatively short period of time. Above a certain threshold level, they push the economy in an upward movement. Reaching that threshold level gives, normally, a situation of heavy competition between the new technologies, filtering out the stronger ones, which then become the new leading sectors. Once these sectors approach their saturation level, the downward phase begins.[12]

In the *macroeconomic approach*, the systems dynamics methodology of Forrester and his MIT group deserves a detailed description. Their goal is to develop a theory with an endogenous structural explanation of the long wave. To avoid problems with collecting sufficient data of good quality, they constructed the so-called System Dynamic National Model (SDNM), based on four mechanisms; namely, self-ordering of capital goods, debt price dynamics, technology and innovation, and political and social values. Of these mechanisms the self-ordering of capital goods, using bootstraps and lags, is seen as the basic one, generating a long wave of its own, while the other three mechanisms simply amplify that wave. These mechanisms are constructed on the basis of the behavior of microeconomic agents, with limited information and bounded rationality in the process of decision making. With this model they show how rational, microeconomic behavior can create irrational consequences on the macrolevel. The validity of their approach is shown by confronting the results generated by this model with actual data for the US economy.[13]

The fourth and last approach, on the importance of *noneconomic variables* in explaining the long wave, is probably the best example of interdisciplinary research in this field. Most authors stress the role of these variables in the long wave, but it has been rather difficult so far to integrate them into the several theories and models in a proper way. Several promising attempts to overcome this obstacle have been made in recent times. Some have analyzed the relationships between long waves and social variables – phases of class struggle, sociopsychological variables, and measures of motivation. Other authors, and in this respect the work of Perez-Perez deserves special attention, have described a theoretical explanation of the long wave, in which the upward phase shows a positive interaction between the technoeconomic and the socioinstitutional systems. In the downward phase, the changing technoeconomic system shows major frictions with an as yet unchanged socioinstitutional environment. Only when this last system has changed too, through the appropriate social and institutional innovations, can a new upswing be unleashed.

3. Some Debatable Issues

After this rather short overview on long waves, I now discuss the following issues in greater detail:

(1) The concept of innovations.

(2) The role of investment.

(3) The process of structural change.

(4) The methodology in the deductive approach.

In explaining the occurrence of long waves, the concept of *innovation* is the most prominent. Firmly based on Schumpeterian insights, authors such as Mensch, Freeman, and Van Duijn have recently developed this concept further; however, each with different accents. Mensch stressed the endogenous character of the process, showing that basic innovations have to appear in clusters before a new upward phase starts, and that innovations differ in character along the long wave. Freeman emphasized the diffusion aspect of innovation, creating new possibilities in many sectors other than the one in which the innovation originated. Van Duijn connected the concept of innovation with that of the product life cycle, in this way introducing the element of leading sectors. Innovations are, according to Van Duijn's opinion, a necessary but not a sufficient condition for the start of a new upswing. Therefore, infrastructural investment on a large scale is also necessary.

With the concept of innovations, it is made clear that technological knowledge, in the broadest sense, does not grow at a constant rate, and that it is a costly process, in both time and money. This vision contrasts strongly with ideas used in most of the neoclassical growth models.

There are, however, also some problems with the concept of innovation. First, there are some methodological problems with respect to both the exact definition and classification of innovations and the exact dating of innovations. Even in more recent analyses the meaning of innovation is mostly curtailed to product and process innovations, at the expense of other features such as the opening of new markets and the introduction of new organizational structures.

The main problem, however, is whether innovations can really generate long waves. Forrester and his group, and also Mandel, have their doubts about this. One of the most critical reviews in this respect was published recently by Rosenberg and Frischtak (1984). They state that the theory does not fulfill the necessary requirements with respect to causality, timing, economy-wide repercussions, and recurrence. They conclude that the concept of innovation as the explanation of the long wave could not yet be validated. I support the main lines of this article, stressing especially the elements of causality and timing. It has not been made clear, in my opinion, why an upward phase starts at a certain moment and which conditions have to be fulfilled, with respect to factor supplies and prices, for instance, to give more positive expectations that, in turn, stimulate investment in those directions. So far, the innovation explanation can only give a good description of the process during the upswing, once it has started.

Another problem with the concept of innovations is related to the large differences in technological knowledge between countries. The normal situation is that some countries have a leading position, while others follow at different rates. Only for the leading countries are new, important innovations a necessary but not sufficient element for the continuation of their economic development. Normally, they cannot compete with their factor prices because there exists a rather strong relationship between the level of technological knowledge and the wage rate. For the other countries this necessity to search for new, important innovations is less strong, because they can try to raise their level of knowledge to that of their precursors by buying patents and licenses, or by copying certain products or organizational structures, thus benefiting from the lower factor costs. Although I endorse the statement that the long wave is an international phenomenon, strongly influenced by the leading, large countries, I also believe that if all the other countries behave according to the life-cycle hypothesis of international production, i.e., by upgrading their structure of production, using already existing technological knowledge, and taking advantage of lower costs, then the impact of the long wave would be less than it actually is. Technological knowledge is available, at a certain price of course, but combined with lower labor costs this must result in profitable production possibilities. That these occur in certain periods and fail in others is, to me, another indication that it is not so much innovation as other factors that are ultimately decisive for a wave-like, long-term economic development.

As is clear from Section 2, in some explanations the role of ***investment*** is important, especially in the approaches of Forrester and Van Duijn. In the explanations that stress the impact of innovations, the role and importance of investment is rather neglected. Wrongly, because innovations need the medium of investment to become effective.

There are two aspects of investment I stress here. In the first place, it is necessary, in my opinion, to take more account of the unpredictable element of "animal spirits". As is well known, an investment decision is dependent on many variables, such as interest rates, availability of innovations or new technological

knowledge, and demand expectations; but it is also dependent on the motivation or willingness to take risks. Sometimes, a situation can occur in which the more objective factors show quite similar values as in the past. Yet, the decision to invest can go a different way because of changes in the more subjective factors.

The second point stresses the concept of time in relation to investment, in two ways. On the one hand, there is a time lapse between the decision to invest and the moment that the investment is completed or, in the case of raw materials or semi-products, the order is fulfilled. The introduction of this kind of lag and delay, as is done in the SDNM, increases the level of reality of any explanation. On the other hand, and even more importantly, a realized investment not only positively influences the production capacity or the level of technological possibilities, but also has a negative impact, in the sense that in the long run it lowers the possibility of adjusting to changing circumstances. The higher the volume of investment in a particular industry or sector over a particular period of time, the more expensive and more time consuming any change becomes, and so the adjustment process can develop more slowly. In this way, firms, industries, sectors, or even countries can experience the consequences of previous, large investment projects, in the sense that, when necessary, disinvestment can be a costly process, both in economic and social terms. This creates a disadvantageous position with respect to those competitors who have yet to start. Of course, previous investments have contributed to economic growth, resulting in higher income, in higher technological knowledge ('learning by doing'), and in more possibilities for new research and development, but in the long run they can hamper, because of vested interests, the necessary process of adjustment when economic conditions begin to change fundamentally.

In considering adjustment I come to the third point of my argument. Adjustment assumes changes in consumer demand, in technology, in competition with other firms at home and abroad, and in sectoral relationships, i.e., in all the internal and external relationships in which a firm, an industry, a sector, or a country is involved. It cannot be stressed enough that *structural change* is characteristic of the economic development of all those countries who have passed the take-off phase of industrialization. Its influence is not limited to the so-called developing countries; it applies as much to the developed or industrialized countries of the western world and centrally planned economies.

In my opinion, economic growth and structural change are two sides of the same medal. Economic growth creates the impulse for change by raising the income level, and so changing consumer preferences; by raising more funds for research and development, for investment, and for providing better educational facilities, and so embodying new technology and the benefits of increasing returns of scale; and by allowing greater use of the international division of labor. However, the continuation of this process is strongly dependent on the way these new opportunities are used, on whether the necessary investments are carried out, and, especially important, on whether these investments are in the right direction. By the term the right direction, I mean that the investments have to influence the process of adjustment in such a way that the newly created structure, be it on the level of a firm, an industry, a sector, but especially of a country, is capable of providing the same facilities of employment and output growth as before. In short, economic growth creates structural changes, but without incorporating these changes economic growth will slow down more and more. Accordingly, as economic growth continues in the upward phase of economic development, more and more is invested in the leading sectors. So just at the time when adjustment is needed to react to occurring changes, towards new leading sectors, there are fewer possibilities, both financial and social, to implement it. In the end, a stationary situation can occur.

In reality, countries differ in their attitude toward adjustment. There is not much argument with the statement that Japan adjusted better toward changes than did other countries post World War II. Therefore, Japan has so far withstood the impact of the worldwide depression better than many other countries. But the Japanese, too, were confronted with adjustment problems and with vested interests that could not be changed without cost. Included in these vested interests are earlier investments in machines, plants, infrastructure, and human capital, that lost profitability because of changes in the consumption or production spheres, both inland or abroad. Also, the institutional structure resembles vested interests in that it cannot change without losses (for some). As long as the costs of implementing changes combined with insecure profit expectations are valued higher than those of remaining static, be this a private or public judgment, the necessary adjustments will not be executed. The consequence is slower growth or even higher costs of adjustment in the future and less opportunities for reorganizing the old economic situation.

With regard to the chosen ***methodology***, the fourth and last point of my argument, I give here a few remarks about the SDNM approach. The two other main methods used for research on long waves are rather well-known. One method comprises the more verbal description, in which a theory is constructed based on a logic sequence of valid arguments, sometimes supplemented with real-life examples. The other method is the statistical/mathematical one, which relies heavily on the availability of data and of statistical methods. A weak element of this approach is the interpretation of the results. To overcome both shortcomings, a research group, under the guidance of Forrester, created the already described SDNM, in which, on the basis of certain assumptions regarding human decision-making, several cycles could be generated that are superimposed on a long wave. In this way they were not dependent on the quality and/or quantity of data and statistical methods available.

If the chosen mechanisms are the right ones, if no important mechanism is forgotten, and especially if the microeconomic behavior of all the agents is translated into the model correctly then this method may be judged as acceptable in long wave analysis. The question now is, whether all these statements can be answered positively. My answer must be in the negative. Although I underline the importance of the self-ordering mechanism, I am of the opinion that other mechanisms are, at least, equally important. In this respect, the influence of new technologies and its gradual working through the whole economic and social structure, and the ongoing changes in rival countries, are both mechanisms that have to be incorporated. Assuming technological progress as an exogenous variable, with a uniform growth rate, gives the same unrealistic description of this phenomenon as in many of the older growth models.

Another point of criticism applies to the translation of microeconomic behavior into the model. Of course, it is a real improvement that, unlike in the more neoclassical oriented economic theory, it is not assumed that economic agents have perfect and costless information or that they are acting as optimizers. However, the model assumes, as far as I am aware, a constancy in human behavior, while in reality changes occur that can greatly influence economic development. Already, changes in "animal spirits" regarding entrepreneurial behavior have been noticed, but changes in expectations about the future, and so about decisions to be made, are relevant for all economic agents. They can create an atmosphere in which self-fulfilling prophecies, both positive and negative, can be realized.

In this short section I have reviewed some elements I judge as crucial. In the next section, I try to sketch a coherent, theoretical framework for explaining the long wave development of industrialized countries, in which economic growth,

structural change, and changing international economic relations are the crucial elements.

4. The Interplay between Economic Growth and Structural Change

In this section I describe the processes of economic development for the more developed, industrialized countries, showing why it is inevitable that periods of relatively high growth and of stagnation alternate. In my view, the crucial relationship is that between economic growth and structural change, in the sense that economic growth is a necessary condition for structural change, while structural change is, in its turn, a necessary condition for prolonged economic growth. As long as this relationship holds, the process of economic development evolves steadily, with prosperous figures for most of the economic indicators. However, for two reasons this process cannot continue indefinitely. On the one hand, structural change slows down because of previous investments in firms, industries, or sectors that are no longer profitable because of a change in the relative competitive position, but that cannot be withdrawn without costs; structural change also slows down because of growing organizational and institutional sclerosis. On the other hand, structural change has to be brought about as soon as (new) competitors start to provide the market with the same products, but of lower price and/or better quality, or when demand shows a secular decline. At that moment the decision has to be made to adjust one's own production to restore the competitiveness or to change the structure of production into other directions. The necessity for these changes conflicts strongly with the growing resistance to change on the part of the production structure. As long as this conflict is not resolved, i.e., as long as the production structure in the broadest sense has not adjusted to the new circumstances, the period of stagnating economic development continues.

In this analysis, the structure of production, in the broadest sense, and that of consumption, as well as the organizational and institutional shaping of the economic process, both at home and abroad, are the basic elements. The introduction of countries abroad into the model means that one has to take account of balance of payments constraints, exchange rates, wage and productivity differences, and the more general price and quality differences between equal products from several countries. With regard to the structure of production and consumption, there are several ways of dividing the economic structure into various sectors or industries. First, a division between competitive and sheltered sectors can be made according to their exposure to competition from other countries. Second, sectors or industries can be divided according to their dependence on final demand. Normally, a division is applied between consumer-good and capital-good production sectors, but in reality a whole spectrum of intermediate positions occurs. The more an industry has a capital-good production character, the more it usually has to invest in its production capacity, and thus the more difficulties it has in adapting to the necessary changes. Third, a division can be made according to the status of leading and following sectors. In each period, certain sectors show a relatively high growth rate because of strong final and/or intermediate/investment demand by other sectors. In these sectors, the development of productivity, prices, and employment is on the whole different from those sectors that are more following. And, fourth, a division according to technological content is possible. As already stated countries show differences in their level of technological knowledge and in their ability to use it. Some countries lead, while most countries follow at a lesser or greater distance. Each country strives for an improvement in its position in this sequence. A country can try to improve its technological knowledge and so create the possibility of making new or better products of higher value, to gain a leading position or to keep at the same level as its competitors.

Which sectoral division is appropriate depends on the kind of questions to be answered.

The structure of both the production and consumption changes as time passes. The structure of consumption undergoes changes mainly because of rising income and its consequences, as described by Engel's Law, which implies a change in consumption expenditures from basic necessities, such as food, to more luxury products. To a lesser extent expenditures are also influenced by relative prices. If we consider only one country, then this change in consumption alone would necessitate a corresponding change in the structure of production. With the introduction of other countries to the model, this necessity increases because, in the long run, an equilibrium position on the balance of payments has to be reached.

The structure of production experiences influences from several directions. Apart from the already mentioned changes in the structure of consumption and in the possibility that new competitors enter the market – a very strong influence – other factors, equally important, are the availability and price of production inputs, the technological development, and the economies of scale. In the process of production several production inputs are used, such as labor, capital through investment, energy, raw materials, and intermediate products. These production inputs are not always in equilibrium between supply and demand. On the contrary, structural discrepancies between supply and demand or sudden price increases of an input can create influential disequilibria on the several markets, which then work through the whole system. Each situation of structural disequilibrium requires a certain kind of adjustment, with sometimes unpredictable consequences. This creates uncertainty and thus influences future expectations negatively. Technological development is one of the main determinants in the whole process. Its rate of growth determines the productivity growth rate, and so the possibility of changing relative prices, in a decisive way. The growth rate of technological development is mainly dependent on the expenditures for research and development and on the amount invested in the production process to apply product or process innovations. The volume of investment depends positively on the volume of demand.

This growth of investment in its turn creates further possibilities for economies of scale, possibilities realized in those sectors that can raise their output level because of rising demand in an existing market or by creating new markets, for instance through more exports.

To clarify this line of reasoning, the main relationships are summarized in two figures. In Figure I, the situation is described for a closed economy. It is possible to distinguish between new, increasing, stagnating, and declining products, industries, or sectors. For each unit, the development along the several phases of the product-life cycle is mainly determined through the interplay of demand factors – income elasticity (Engel's law) and disposable income – on the one hand, and supply factors – quantity, quality, and price of production factors, intermediate deliveries and resources, and technological development – on the other. This results in a specific pattern of productivity and price and quality development, and so of realized sales, employment, and profits.

Simply because of economic growth, each product moves along the relevant product cycle, implying changes in the use of capital and labor. Some products increase their demand for production factors; others, however, decrease their demand, which leads to redundant capital stock and the discharging of labor. When the respective increases and decreases in demand for production factors match each other exactly, in time, in quantity, in quality, and in place, i.e., when structural changes in the several factor markets are realized, then an important condition for the continuation of growth is realized. However, another condition, equal-

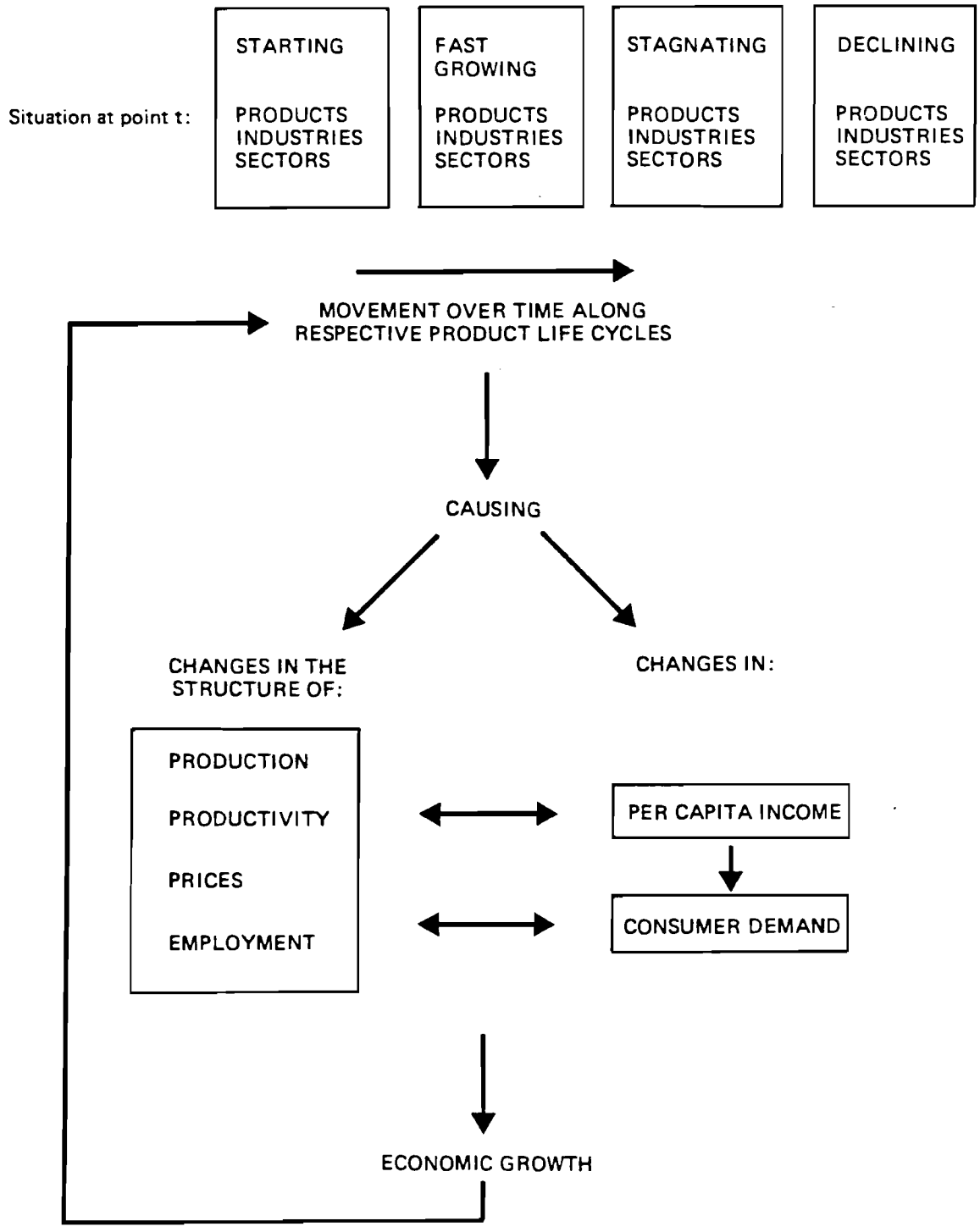

Figure I. The relationship between economic growth and structural change in a closed economy.

ly necessary, is the introduction of new products on the market to secure growth possibilities.

Whether all these necessary adjustments are made is strongly dependent on the way that different firms view the developments, and how they translate their observations into investment behavior and into market policy with respect to prices and sales. Both investors and consumers must also continue to have positive expectations about the future, because otherwise the lack of demand negatively influences the expectations of other actors.

In the second scheme, the rather unrealistic assumption of a closed economy is removed. Four different elements have to be taken into account in this respect. There is probably no country in the world that does not have to rely on other countries. This implies – and this is the first element – that trade occurs in those products that cannot be produced in a country. Some natural resources and agricultural products belong to this category. For the second element, trade in industrialized products, the characteristic of not being able to produce one's own goods is in most cases not relevant. Although there are important differences in technological knowledge between countries – see the third element – a major part of the trade in industrial products occurs even when the importing country has the potential to produce such products internally, or even actually produces and exports them (intra-industry trade). Trade in industrial products is caused by the international division of labor, making use of the possibility of specialization, by important differences in factor rewards between countries, especially with regard to labor, and by the established fact that with a higher income there occurs a stronger preference for products from other countries because of quality differences (the Linder effect). As stated already – and this is the third element – there are major differences in technological knowledge between countries. Some have a leading position, operating on the technological frontier. Normally, new products are introduced in these countries, because of the available knowledge to produce them and because of a suitable market in which to sell them. Behind the leaders, the other countries follow successively, some not far behind and some way back from that leader. This order is, of course, not fixed. Countries with a technological lag try to catch up with the technological leader, as was very visible post World War II, through their own research and development, but especially through buying patents and licenses. Combined with lower labor costs, they can achieve a very competitive position on markets that had been held by those countries with a technological lead. Conversely, the leading countries try to hold their position or even improve upon it by commanding enough funds for research and development. The fourth element, that of direct investments abroad, once again strengthens the possibility of changes in the relative order with respect to technology. Direct investment in the host country, whether or not with a positive influence for that economy, implies that investment in the home country is lower than otherwise possible. In this way, direct investments can negatively influence the economy in which the funds originated. The introduction of an open economy increases the number of factors that cause structural changes, in comparison with closed economies, such as in Figure I. In Figure II, the situation is sketched for an economy with external relations with the rest of the world. Five different relationships can be indicated.

The relations between the several production structures are indicated with an A. As described, they range from tradeflows of physical production-inputs to shifts of technological knowledge, whether or not combined with direct investments. These relations can change the process of adjustment within the respective countries as well as in their relative position. If there are less funds available for the investment necessary to incorporate new technology or to create it, or to follow changes in consumption patterns, because these funds are used in other countries, then the income generated will be lower than otherwise, and so less funds

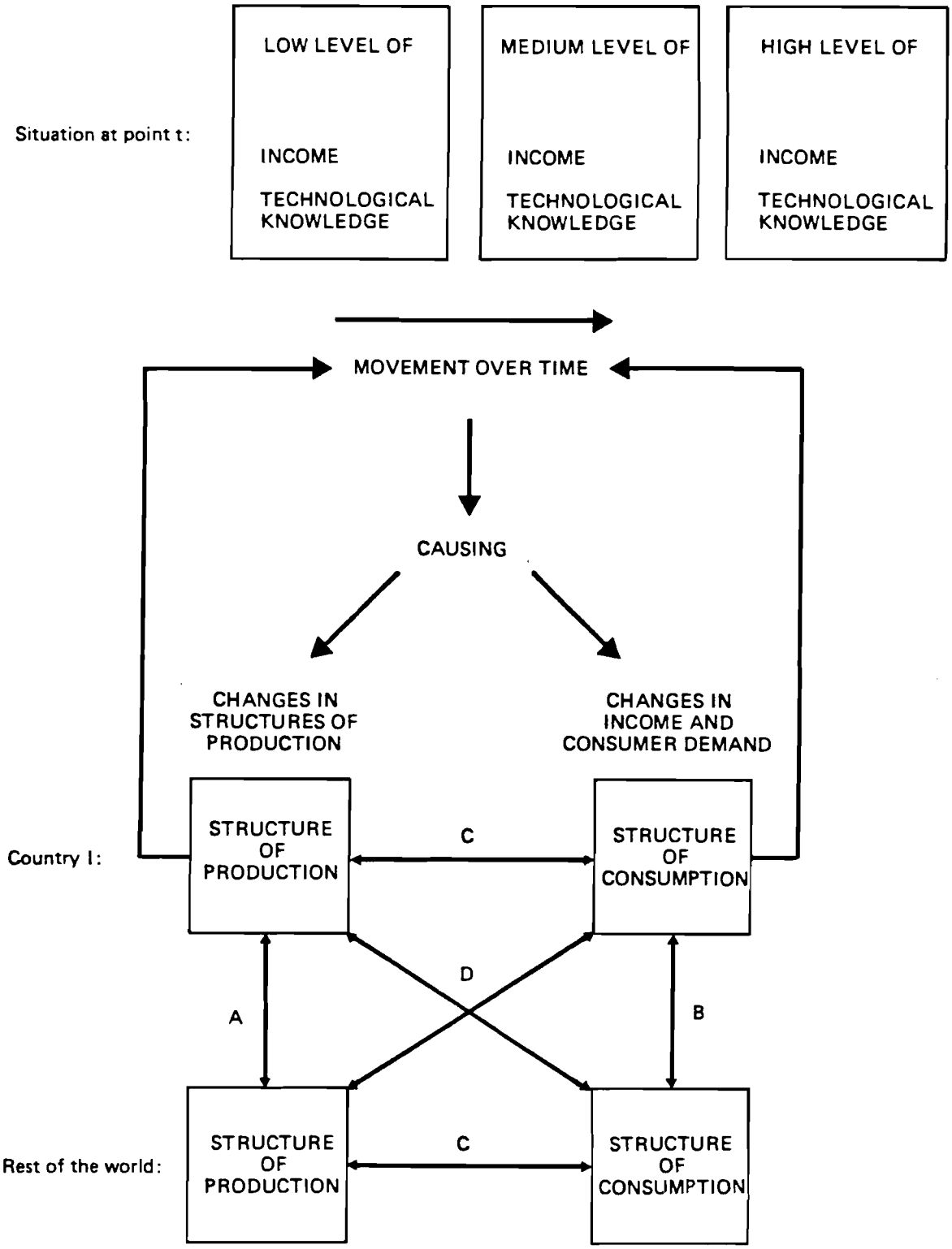

Figure II. The relationship between economic growth and structural change of production and consumption in an interconnected world.

are available in the future. The reverse is, of course, also possible.

The relations under B describe the "keeping up with the Jones'" effect at the national level. The consumption pattern of the technological leader forms the blueprint for the other economies. They follow with a certain delay, their consumption pattern is often, rather advanced compared with the existing structure of production.

C indicates the relations that represent the flows of products produced in a particular area and consumed in that same area. This means that these products have a quality and price that is judged preferable to those from other countries. This by no means implies a stable situation. Changing consumer preferences, or a relative change in the technological ordering, and/or changes in productivity, respective input prices, and exchange rates, are elements that continuously exert pressures on the production structure to adjust in order to continue the process of growth and to prevent unemployment.

Otherwise, and this is represented by the relations under D, changes in international trade flows occur, which can correct the absence of certain adjustments. Possibilities of this nature are, for a country, rather limited because of the balance of payments constraint. International trade relations can be a danger to the national economy, as when consumers and investors show an increasing preference for the lower price and/or the better quality of products from abroad.

From this more schematic description, it has hopefully become clear to the reader how extensive are the variety of changes and the possible determinants that occur in the process of economic development. Such and analysis renders the questions of whether these changes are realized correctly, and if not what the consequences are and how they can be neutralized, even more pregnant. A possible scenario is given in section 5.

5. A Sketch of a Possible Explanation of the Long Wave

In this section, I sketch briefly a long wave process of economic development in which endogenous factors are ultimately responsible for the alternation of up- and down-swing.

In this description of economic development according to a long wave pattern, in which I incorporate no strict time pattern, I discern the four usual phases of the cycle: recovery, prosperity, recession, and depression.

A graphic representation is given in Figure III. The cycle shows the smoothed deviations from the long-term trend. The dating of the phases is connected with the points of inflection on this cycle. The phases of prosperity and of depression show a more or less uniform pattern of deviation development, be it positive or negative. The other two phases show the transition of the positive development of the deviations into the negative era and vice versa. Whether these phases of transition, recovery, and recession start at the points indicated is problematic. In the case of recovery, for instance, growth has not yet reached the level of long-term growth. However, just as with the famous accelerator mechanism, a smaller decline than before can have a profound influence on the expectations of the several economic actors, and so on the decisions made. Once investment, as the most important determinant, has started to rise, making the development of new sectors possible, the whole situation changes drastically. With regard to the length of the cycle, the major differences between the several cycles are caused in the phases of recession and depression. In these phases, human decision-making is decisive, while in the upward phase the technoeconomic forces ultimately influence the pace of development. Therefore, three different cycles are sketched as examples, each

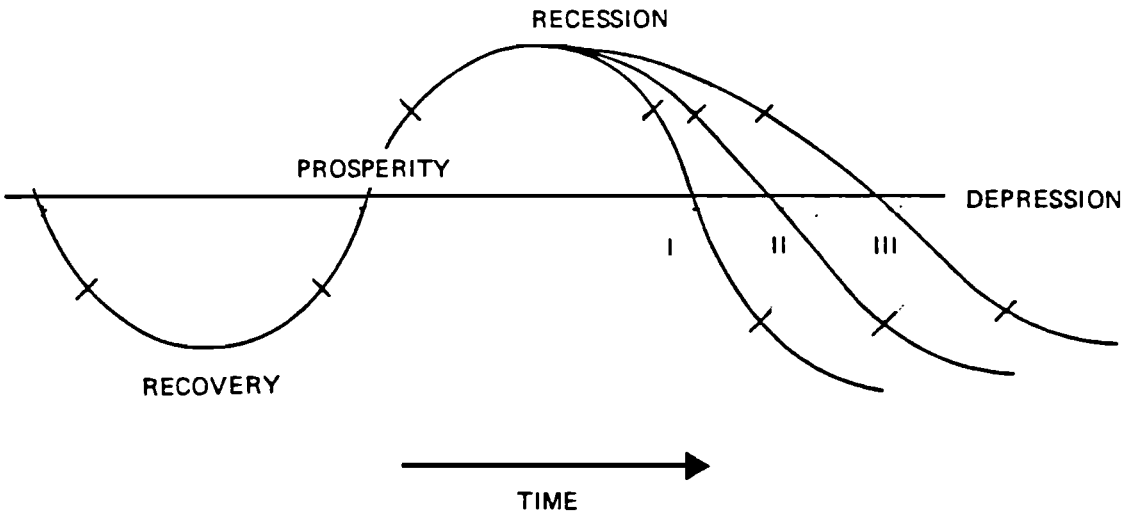

Figure III. Possible courses of a long wave-like development, showing smoothed deviations of the long-term trend, and the dating of several phases.

equally probable.

The phase of *recovery* is said to start at that moment when several necessary requirements for growth are fulfilled, requirements with regard to a broad range of (non)economic variables. The most important requirement to be met is that the structure of production, for intermediate and final demand, and the structure of consumption be more or less comparable, with a stable balance of payments. This means that the production structure has adjusted as close as possible to the requirements of the consumption structure, inland as well as abroad, in the sense that the structurally unprofitable parts were scrapped in the preceding phase of depression. The nonprofitability was caused either by declining consumer demand, because of saturation when income was raised, or by the rise in competitiveness in these sectors in other countries. This scrapping inevitably meant not only that capital goods, machines, buildings, etc., were made redundant, but also that labor, once employed in these sectors, had to move to other segments during a time of high unemployment a consequence difficult to accept. More general organizational and institutional changes were equally required. This process of scrapping does not work out smoothly and gradually. It is costly, from the economic and social viewpoint, and people, be it investors, laborers, or society in general, will firmly resist in the first instances. At such times, the costs of changing are valued higher than those of retaining the status quo. After a period, the length of which is dependent on the importance of the old structures, however, changes occur. The investors cut their losses, laborers lose their jobs, and, also at the institutional level old positions are given up. Sometimes, this process of scrapping, of accepting the necessity of changes, can be accelerated by major events, of which war has been the most prominent, but also the most terrible one. Such an event shakes the

whole society to its core and creates an environment in which even major changes are acceptable. In this respect, it is remarkable to see that the two countries who lost World War II, with the resultant enormous destruction and completely disarranged social structure, Japan and Germany, have shown the most prosperous economic development.

The second main requirement is a change in motivation. I am of the opinion, that motivation – the attitude to look for something new, to take risks, to change, i.e. entrepreneurship in the widest sense – is a major determinant in economic development, too much neglected in economic theory, not so much with respect to investors, but with respect to all those whose cooperation is needed to make an investment successful. Of course, this determinant is strongly connected with the first one, but it has its own value. Most of the changes needed involve the cooperation of all those concerned, be it on the level of a firm, a sector, or a national state with regard to changes in the social infrastructure. Also, here, changes imply losses for some participants, especially in the short term. These changes are, however, necessary to realize certain long-term goals. If the cooperation is not present, if there is no motivation to change, then the implemented changes will fail to achieve the desired goals. Examples of periods in which motivation has had an important influence are the period after World War II, the so-called "postwar reconstruction" period in Europe, and the Japanese way of organization in more recent times.

The question now arises whether something can be said about the major influences on the willingness to adjust and the motivation to execute. Several arguments in this respect can be given. On the national level, the price for the major production factors, capital, and labor, showns a relative decrease during the preceding years of recession and depression, because supply was larger than demand for a longer period of time. These conditions lower the risks of new investments, investments that can draw from a reservoir of new technological knowledge, and product and process innovations. These innovations are sometimes known already, but have so far not been implemented because of the unfavorable economic situation. Another impulse can be given through government investments in the infrastructure, a measure that can have a positive influence on future expectations and so on general motivation.

But the most important reason for entering a period of recovery is that the majority of the industrialized countries show the same positive developments. It is impossible for any country to recover successfully on its own. The demand for imported products created in other countries can yield very positive results, if and only if the basic requirements in the exporting country – an adjusted production structure and a positive motivation – are fulfilled. If this is the case, the countries involved can have a very positive influence on each other, in such a way that the economic development of the industrialized world increases.

At the end of the phase of recovery, entering the period of *prosperity*, in many countries certain recognizable sectors show a real breakthrough in their development. Until this point, these sectors have gone through a period of very risky investments, with many experimentations and also with the overcoming of major problems in the technical sphere, in the way the process of production is organized, and/or in the way that society is equipped to reap the fruits of these developments.

But as soon as the demanding side, be it consumer for final demand or other producers in the case of capital- or intermediate-goods, has realized the special, new character of the products of these sectors, a process of fast growth develops. This strong demand enables the sector to realize further investments, so strongly influencing productivity growth and relative prices. Lower prices strengthen

demand even more, and so a vicious circle of development becomes possible.

The influence of leading sectors is, however, not restricted to these specific sectors themselves. Because of strong backward- and forwarding-linkages they influence other sectors, and so the economic structure in general, profoundly. On the one hand, their demand for inputs is strong, so creating economies of scale in the delivering sectors. On the other hand, when the leading sector produces a major new capital good, it gives a strong impulse to other sectors to adjust, not only by lowering the cost of production, but still more by creating new, unforeseen possibilities for new products and/or new markets.

All these investments and the increasing demand have, of course, their normal multiplier influences on the economy. The resultant strong demand for the production factors, capital and labor can be met in the first instance rather easily. Money-lenders are eager to profit from the positive economic development. The labor force moves into these new sectors, in the beginning attracted by the available job opportunities. But eventually demand comes close to supply. The resultant increases in interest and wages, especially through demands in the stronger, leading sectors, create a further impulse for production factors to move from the lower profit sectors to the higher profit, fast growing sectors. These high profit sectors, with their high productivity growth, can more easily pay the high wages than can those other sectors with a more lagging development.

However, a period of prosperity does not only have developments with positive consequences. It produces also the seeds that eventually begin to cripple the process of economic development. From the time of recovery on, the structure of production is characterized by large and continuous changes in the creation of new products and markets and/or in applying new production methods. This behavior, directed at changes, receives a new impulse when the prices for labor and capital start to rise. However, as already said, only the fast growing sectors are able to pay these increases through productivity growth. This reduces their ability to lower their prices further and so to explore new markets. It also brings about a change in their investment policies. So far, product innovations are amply implemented, but gradually process innovations obtain the upper hand. The reason for a stronger emphasis on process innovations is that investors become more interested in protecting the already realized investment projects than in starting new, risky projects. For other sectors the increases in factor prices can only be met by price increases and/or forced process innovations. These higher prices influence, in their turn, the general price level of the economy in a negative way. The application of process innovations normally means the loss of employment opportunities, a loss that at the time, however, is not really a problem. The change in the character of innovations, the rise of the production factor prices, and the increase in the general price level are the first, not unimportant, signs that the process of economic development is undergoing a change in character, in which the process of adjustment of the economic structure starts to slow down. And this occurs just when an even a higher pace of adjustment is needed, for two reasons.

The first is that in the phase of recovery and also in the beginning of the prosperity phase the structure of consumption remains rather stable. The high rate of unemployment, to a large extent, prevents real wage rises. As soon as this situation changes, however, strong wage increases are demanded and agreed, raising the level of per capita income, and so changing the structure of consumption. Also the relative price developments, favorable for the fast growing sectors, cause changes in the consumption structure. Another consequence of the per capita income rise is that consumers show a greater preference for products from other countries, not only because of possible price differences, but also because of quality, and nonprice characteristics. As long as this loss of internal demand can

be compensated through higher export sales, no real problems occur. On the contrary, all the countries involved can, in theory, profit from the resultant economies of scale and from the stronger international division of labor. The main question is whether the existing national structure of production is optimal in creating the right products in the right way, to participate optimally in this process, so to realize fully the theoretical possibilities.

The second main reason why a stronger pace of adjustment is needed relates to the growth of other countries, in two ways. On the one hand, the fastest growing countries show the same virtuous circle of development, as already described for certain sectors: strong demand creates sufficient funds for investment, which stimulates productivity growth and lowers prices, influencing demand once again positively. Those countries with such a development have much better opportunities to adjust than those who are in the vicious circle of demand: slow growth of demand, less funds for investment, with only small productivity increases that do not result in a stronger competitive position and so do not create new demand. The slow growing countries, starting in a bad position, have no real opportunity to make up their arrears. But the dangers do not only emanate from competitors with a good starting position and a strong economic growth. The strong economic growth of the more industrialized world in general induces several not yet industrialized countries to start to participate too in that development. This is the other side of the process that urges for adjustment. Because of very favorable conditions with regard to factor prices, i.e., low labor costs and the available low-level technology, mostly due to the direct investment of multi-national companies, these countries can induce, in this way, a fast process of industrialization. When started, this process can create funds for new investment allowing further industrialization.

The friction between the actual slower adjustment of the structure of production on the one hand, and the stronger adjustment requirements on the other, ranging from changes in the structure of consumption to the entrance of new competitors on the world market, influences future expectations negatively, creates unemployment, undermines profits, and, more generally, lowers the motivation of the several economic actors. Instead of realizing the necessary adjustments, participants in the economic process, investors, entrepreneurs, laborers' organizations, etc., take a more defensive attitude to prevent a further eroding of their (profitability) position.

National demand slows down, especially because of declining investments. The end result is that larger losses occur than otherwise would have been the case. The situation deteriorates even further because adjustment pressures are felt in most of the countries involved in the world economic system. Although there are, sometimes important, differences, each country has in a quite similar and growing gap between the actual and the needed structures of production. This economic contraction reduces further the growth of international trade, and so that of export demand for individual countries. A period of recession becomes inevitable.

This period of *recession* is, in the first instance, characterized by high interest rates and high wages. Investors and/or companies are more active in protecting their existing projects – through government subsidies, protection against competitors from other countries, and streamlining the production process as much as possible – than they are in creating new projects and realizing the necessary changes. Consumers react slower to the changing tides. The change in the consumption structure prevails for a while, before it is realized that the economic circumstances have changed so drastically that a continuation of the old ways is impossible. With creeping unemployment, laborers are not so willing anymore to move, thus contributing to a rigid labor market. Organizations and, more generally, commonly accepted policies, constructed in periods of high growth and having

contributed to the success in a not unimportant manner, cannot really handle these new circumstances, and take also a defensive position. In short, the economic development stagnates with all the negative consequences on income, employment, and output, and nothing seems to have enough power to stop this.

This phase of recession shades off into that of *depression* when the prices for credit and labor start to go down, but especially when noncompetitive firms and/or sectors go bankrupt. In their ultimate decline, they drag other firms with them. Unemployment rises very fast, which results in a stronger pressure on governments to assist firms and/or sectors in trouble to protect the remaining jobs. However socially acceptable such a policy may be, it distracts funds from possible areas that could have been more profitable, in the long run, for the whole of society, by realizing the necessary adjustments in the structure of production. The resistance of society against these measures is normally already very strong. To close down certain firms or even to liquidate whole sectors is, however, a harsh measure at a time when unemployment rates are still rising. From the economic point of view, only through taking these kinds of measures is it possible to achieve a starting point that is favorable for a new recovery phase. It is clear, however, that this process of adjustment is long, painful, and sometimes also dangerous. As historical experience has shown and shows now once again, the phases of recession and depression have a strong influence on public opinion. During a depression the economy erodes the basic values of 200 years of industrial civilization i.e., the strive toward growth and the enjoyment of its fruits. This erosion has a negative effect on people's attitudes. A conservative, defensive attitude gains the upper hand, an attitude that is not only restricted to economic areas, but also to the social and political organizations as well. In such a climate, nationalistic feelings are stimulated strongly, creating an atmosphere in which more and more internal and external pressures are used to defend the interests of certain groups inside a country or of a certain country against others. In such a climate, aggressive or even fascist-oriented ideas can have a decisive influence if no real alternatives are available to overcome the problems just described. It is therefore necessary to construct a policy that is effective and acceptable, effective in realizing the required adjustments and acceptable in that it makes clear what the costs and benefits of this policy are compared with other possibilities. In such a program, it has to be made clear that certain adjustments, however painful for certain groups, have to be carried out to provide a more positive, long-term development, but equally, it has to be made clear why these adjustments are necessary and what the reasoning behind the policy is. One thing is clear: the longer one holds back from such a policy, the more painful the adjustments are.

6. Concluding Remarks

To conclude this working paper, I use this final section not just to repeat the main line of the argument, but also to present some thoughts on a desired economic development.

In my opinion, industrialized countries show a long wave pattern with a duration between 40 and 60 years. The main reason behind this pattern is the alternation of periods with strong and fast changes in the structure of production – here used in the widest sense, comprising the whole of economic, technological, organizational, and institutional relations as perceived in a country – and periods with no or slow changes only. Developments in the field of technological progress, and later on in the structure of consumption, and especially in the structures of production of other countries, require, however, a continuous process of adjustment in the structure of production. That this does not happen is because of the impossibility to keep the motivation of all the economic actors operating at such a level

as is necessary for the process of adjustment. In certain periods, this motivation is clearly present, but as soon as vested interests become important and/or as soon as these interests are threatened because of continuing changes elsewhere, the positive motivation to change alters to a more defensive one, which tries to retain the status quo as long as possible. The stronger the optimistic with respect to the defensive mood, the longer the duration of the upward with respect to the downward phase.

That the long wave is an international phenomenon, with a remarkable correspondence, can be explained by the fact that, on the one hand, sometimes major events influence a large number of countries at the same time, and, on the other hand, that the differences in growth and change between countries is felt by all those participating in the world economy. An example of the first explanation is World War II, which shook societies to their core, thus creating a very strong demand and making possible major changes in the social and institutional frameworks. An example of the second explanation is Japan and, to a lesser extent, the NICs.

A long wave starts its upward phase when a majority of the countries, with respect to their economic importance, have reached a kind of equilibrium between their production and consumption structures, with a reasonable balance of payments. In the upward phase the structure of production changes fast, while the structure of consumption starts to change only after a delay. Because of growing vested interests, the changes in the structure of production slow down, just when changes in other countries, especially, demand a faster process of change occurs. The increasing mismatch between the actual and the required structure of production causes rigidity on many different levels and markets. This rigidity characterizes the recession phase, while the depression phase shows the painful, slow process of adjustment of the structure of production to the new circumstances.

In considering again the questions posed in the Introduction as to the strongness and durability of economic recovery, I am inclined to say that the industrialized world has not yet reached the lower turning point of the long wave. In my opinion, the necessary adjustments of the production structure are not yet all executed totally, while the rigidity on the various levels – in the form of protectionism, resistance to change, gloomy forecasts – still exists. Of course, the first steps have been taken, but end is not yet reached.

This sounds negative, and it is in a certain way. It means that more painful operations have to be done. However, it gives us also the possibility to think a bit more about the desired economic development. Do we want a situation of economic growth comparable with the post World War II experience, or is there a preference for slower growth?

What the advantages are of a recovery with a strong economic growth do not need explanation. Most people/countries have a strong preference for a higher income, to be able to fulfill more consumer wants. (Whether this makes people more happy is another question!). This preference for growth has been a common characteristic of the economic behavior of the industrialized countries.

The disadvantages of such a growth option are also clear. On the whole the consequences for the environment, for the quality of labor, for the reasonable use of raw materials supplies, and for the Third World Countries have to be considered as being much less positive. More and more people have become convinced of these negative consequences. Also, the process of adjustment that must occur gives a negative impact on the pro-growth option.

But is it then possible to change to a low growth option? At first sight, this looks a rather promising option, especially for the environment, labor quality, and the use of raw materials supplies. For the Third World Countries the answer is already ambivalent. But the main question remains: Is this option a reasonable one for industrialized countries?

Two answers are possible. The answer is no if the choice also implies the absence of further structural changes. If that occurs, the situation will deteriorate rather fast, assuming that not all the countries will choose for this option and that consumers retain, in the first instance, the freedom to choose. Of course, restrictions in this area are possible, but they are not seen as a viable solution.

The answer is maybe yes if a continuation of structural change is accepted. In this case, such adjustments could be made that make a low-growth solution possible without restricting too much the freedom of consumption and that of international trade. I have written "maybe" because I do not have clear ideas as to what kind of adjustments are needed or as to the economic viability of this option. The doubt is also suggested because of a social reason, namely whether an industrialized, developed country, in which growth has been the major social value for centuries, can strive for a low-growth option without creating severe social tensions. This is maybe the most important argument that could prevent such an option. The possible social consequences of the downward phase of a long wave, mentioned at the end of the last section, make my expectations not really optimistic.

To find suitable solutions to the problems sketched and the questions posed, taking into account the multidisciplinary and international character of the long wave phenomenon, more research is needed. Institutions like IIASA could play a central role in this. Will this challenge be accepted?

NOTES

1. As an aside, sometimes the striking negative correlation between the long-wave development of the economy and the number of publications on this topic is noted. If this correlation is significant, than the economy has not reached its downturn yet, according to the still growing number of publications.
2. See Van Paridon (1979 a,b, 1982, and 1984).
3. See Freeman (1982), Freeman *et al.* (1982), van Duijn (1983), and Delbeke (1981, 1984).
4. Delbeke made this survey on the basis of the proceedings of the Siena/Florence meeting on long waves, held in October 1983. Most of the experts on long waves participated in this conference. The material was published in Bianchi (1983 and 1985). Delbeke's paper was included in the proceedings (see Bianchi a.o., 1985), but was also published independently (Delbeke, 1984).
5. This opinion is based on our own research (Van Paridon, 1979 a,b), but especially on Bieshaar and Kleinknecht (1984), Van Duijn (1983), and Metz (1984).
6. The following description of the several theoretical approaches on the explanation of the long wave is strongly dependent on Delbeke (1981, 1984).
7. For a closer description of the several theories, see Delbeke (1981). To give an indication, authors are here mentioned according to the main determinant in their approach:

Capital:	Forrester (SDNM), Mandel, Van Duijn
Labor:	Freeman (SPRU)
Raw materials:	Rostow
Entrepreneurship/innovation:	Mensch, Van Duijn

8. See Delbeke (1984). Exceptions are Senge (SDNM) and Delbeke and Schokkaert.
9. See Delbeke (1984), with Perez-Perez, Gordon, Edwards and Reich, and Glissmann and Wolter, as the main representatives.
10. Delbeke, (1984), p. 6.
11. See Freeman (1982).
12. See the article of Mensch in Bianchi *et al.* (1983).
13. See the article by Forrester *et al.* in Bianchi *et al.* (1983), and Sterman (1984).
14. Whether a country can always reap these fruits is another question, as is whether direct investment by these companies can be judged as a profitable development for a country.

REFERENCES

Bianchi, G., G. Bruckmann and T. Vasko (Eds). (1983). ***Background material for a Meeting on Long Waves, Depression and Innovation***, Siena/Florence, October 26-29, 1983. IIASA, Laxenburg, CP-83-44.

Bianchi, G., G. Bruckmann, J. Delbeke and T. Vasko (Eds). 1985. Long Waves, Depression and Innovation: Implications for National and Regional Economic Policy. Proceedings of the Siena/Florence Meeting (26-30 October 1983). IIASA, Laxenburg, CP-85-9.

Bieshaar, H. and A. Kleinknecht, (1984). *Kondratieff Long Waves in Aggregate Output? An Econometric Test.* IIASA, Laxenburg, CP-84-34

Delbeke, J. (1981). Recent long wave theories. A critical survey. *Futures*, Vol. 13, p. 246-257.

Delbeke, J. (1984). *The State of the Art of Long Wave Research Anno 1983.* IIASA, Laxenburg, CP-84-53.

Freeman C. (ed) (1982). *Long Waves in the World Economy.* Guildford, Butterworth.

Freeman, C., J. Clark and L. Soete (1982). *Unemployment and Technical Innovation.* London, Frances Pinter.

Metz, R. (1984). Zur empirischen Evidenz "langer Wellen". *Kyklos*, Vol. 37, p. 266-290.

OECD (1984), *Economic Outlook*, No. 35, Paris

Rosenberg, N. and C.R. Frischtak. (1984). Technological innovation and long waves. Cambridge Journal of Economics, Vol. 8, p. 7-24.

Sterman, J.D. (1984). *An Integrated Theory of the Economic Long Wave.* WP-1563-84, Massachusetts Institute of Technology, Cambridge.

Van Duijn, J.J. (1983). *The Long Wave in Economic Life.* London, George Allen and Unwin.

Van Paridon, C.W.A.M. (1979a). *Lange golven in het economisch leven (Long Waves in Economic Life).* Unpublished Master's thesis.

Van Paridon, C.W.A.M. (1979b). Onderzoek naar de lange golven in Het economisch leven (Study on the long waves in economic life), *Maandschift Economie*, Vol. 43, p. 227-238 and p. 280-298.

Van Paridon, C.W.A.M. (1982). *De Handelsrelatie van Nederland met de Bonds Republiek Duitsland. Belangrijk, maar niet uitzonderlijk. (The trade relations between the Netherlands and the Federal Republic of Germany: Important but not Exceptional).* Published by the Scientific Council for Governmental Policy, Staatsuitgeverij, Den Haag.

Van Paridon, C.W.A.M. (1984). Theorie over de lange golf. (A theory on the long wave), in C.W. Schouten (ed), *De Lange Golf (The Long Wave) SMO-Informatief* 1984-1 Den Haag, pp. 32-36.