British Electronics and Competition with Newly Industrialising Countries

VINCENT CABLE
and
JEREMY CLARKE

odi

British Electronics and Competition with Newly Industrialising Countries

Vincent Cable and Jeremy Clarke

odi OVERSEAS DEVELOPMENT INSTITUTE, LONDON

Overseas Development Institute

The Overseas Development Institute (ODI) is an independent non-government body aiming to promote wise action in the field of overseas development. It was set up in 1960 and is financed by donations from British business and by grants from British and American foundations and other sources. Its policies are determined by its Council.

The functions of the Institute are:

1 to provide a centre for research in development issues and problems and to conduct studies of its own;

2 to be a forum for the exchange of views and information among those, in Britain and abroad, who are directly concerned with overseas development in business, in government, and in other organisations;

3 to keep the gravity of development issues and problems before the public and the responsible authorities.

10-11 Percy Street, London, W1P, OJB, England

ISBN 0 85003 076 5

Contents

Acknowledgements

The research presented in this book would not have been possible without the generous assistance of those directly involved in the consumer electronics industry. In particular, we would like to thank the manufacturers' association BREMA, the National Economic Development Office, the Amalgamated Union of Engineering Workers (TASS), the Electrical Electronic Telecommunications and Plumbing Union, and the representatives of Thorn-EMI, National Panasonic (UK), GEC, Fidelity Radio, and Radiomobile who spared the time to talk to us. We would also like to thank the Hong Kong Government Office for providing background material on the South East Asian industry. Thanks are also due to Tony Killick, Robert Wood, and Margaret Cornell of ODI for reading and commenting on earlier drafts, and to Patsy De Souza and Margaret Beringer for typing the manuscript. Finally, thanks are due to the German Marshall Fund of the United States for providing financial support for the study.

Introduction

This study is prompted by the growing concern in Western countries, including Britain, about competition from developing countries (ldcs) in the form of manufactured exports, and the need to frame a response in terms of trade policy and/or means to facilitate industrial adjustment. One way of analysing the problem is through sector case studies. Electrical engineering represents a particularly important case. It is an industry (or group of industries) which has, in some branches, very high levels or rates of growth of import penetration from ldcs. It is also an industry adjusting not only to trade flows but also to technical change. It is thus admirably placed to give insights into interactions between technological and trade adjustment.

The study will draw upon two partly overlapping, partly distinct areas of theory and policy analysis. One has emerged from studies of the determinants of the patterns of international trade, and in particular of the nature of 'comparative advantage' in ldcs with abundant supplies of 'cheap' labour, and of the mechanisms by which developed countries (dcs) adjust (or not) to consequential imports. The other area of analysis has dealt with the impact on both dcs and ldcs of new technology and of the terms and conditions under which this is transferred from the former to the latter. An understanding of international trade

in electrical goods calls for a confluence of both these streams of thought, since ldc performance in trade in industries, like this, characterised by rapid technological changes, is affected by when and how new technology is transferred to them.

The main insights in this area are likely to come from analysis (or even speculation) at a fairly general level. But the bare bones of generality need to be fleshed out with detail such as can be obtained from looking at the lessons of recent experience in one developed country[1] changing in response to the combined influences of technical change and competing trade.[2] The UK is an interesting example since its recent economic history, more than that of any other industrial country, points to the difficulties of achieving rapid industrial adjustment. In trade with developing countries there have been signs of reluctance to accommodate greater competition - at least in the British market where the authorities have some control over events. This is exemplified by a series of restrictive measures in the late 1970s in the field of consumer electronics directed against 'Newly Industrialising Countries' (NICs) in the Far East. There is an apparently growing consciousness, in this area, of 'severe problems in competing with low cost products from the Far East particularly Japan and more recently Taiwan, Singapore and Korea[3] and a less immediate but real concern about the longer term when more ldcs seriously enter the field and those already in it progress to more sophisticated items.

To a degree, there is nothing special in British experience which is not found in most other 'advanced' industrial countries. In particular, the syndrome which is often encountered in discussions on trade in electronic goods - that Britain is being impossibly squeezed between the advanced-technology leaders, Japan and the USA,

on the one hand and the low labour cost, technological followers on the other - is commonly expressed also in France, Italy, Canada, and even Germany: 'the whole European consumer electronics industry is threatened by Far Eastern competition, some countries being in an even worse position than the UK'.[4] The extent to which Britain's experience and policy framework is common, or a product of a particular history of relative economic decline, could only emerge from comparative analysis. This study has more modest objectives and looks at Britain alone.

The limitations of a study based on the response of one developed country to changes in one sector are clear. And there are other difficulties which must honestly be stated from the outset. The first is that the significance of recent advances in micro-electronics goes far beyond the industry defined in terms of electronic *products*. The new electronics technology is also beginning to revolutionise *processes*, across manufacturing industry, and in services. Electronics has aptly been described as a 'convergence' industry rather than one which is self-contained. Its eventual impact on ldc-dc trade in textiles and clothing may prove ultimately more important than on electronics goods, *per se*.[5] Second, the area is one which, because it is rapidly changing, generates data which are frequently out of date or misleading. New products are now being exported by some ldcs - such as electronic games, or digital watches - which are not yet separately identified in trade or production statistics. Recorded trade flows lag years behind what has happened, let alone what is currently planned. A certain amount of anecdote and informed speculation is therefore necessary to supplement the facts. Third, the impact of competition is inevitably felt most acutely in the form of direct imports. But import substitution in ldcs, and inter-ldc trade, are also

'competitive' in a wider sense. The sophistication of electrical machinery production and trade, albeit of a somewhat specialised kind, which has permitted the Indians to put a rocket into space and the Brazilians and Indians to produce jet aircraft, may ultimately prove of greater competitive importance for the British economy than Hong Kong cassette recorders and Taiwanese pen-watches. Fourth, only a handful of ldcs, so far, have anything which could meaningfully be called an electrical goods industry, and half a dozen, mainly Far Eastern NICs, provide almost all the exports. It is increasingly questionable whether most of the latter should, analytically, be treated any longer as 'low wage' developing countries. Their experience may, moreover, be a poor guide in terms of what we should expect from other ldcs seeking to follow in a similar path with different economic and social structures, in different international conditions and when industrial technology has undergone massive changes. However, Far Eastern NICs provide virtually all the evidence we have.

A final comment, which it is necessary to make by way of preface, is that we are dealing with an 'industry' or set of industries whose identity is not at all clear. The electronics industry consists of those products or systems that use electronic circuits handling small currents which incorporate 'active' components capable of modifying the flow of electricity. They should be distinguished from electromechanical products which use mainly mechanical devices and rely upon the conduction of electricity for their operation. The broad definition of 'electrical engineering' covers both. Appendix 1 is devoted to unscrambling some of the definitional questions in more detail. Roughly 50% of British 'electrical engineering' is now classified as 'electronic' but the boundary is hazy and constantly shifting. Products previously reliant

on electromechanical devices to operate them - such as telephone exchanges - are gradually being replaced by electronic systems. Others - such as washing machines or cars - may pass the 'crossover point' in several years' time. And there are 'electronic products' being developed well outside anything regarded until recently as 'electrical', such as office machinery. All this makes serious statistical analysis difficult. In this study the terms 'electrical' and 'electronic' are not always very precisely defined. The emphasis is on 'electronic' products since this is where the interaction between technical change and trading comparative advantage, in trade with ldcs, has occurred.

The Global Picture

A. ELECTRICAL ENGINEERING GOODS, ELECTRONICS AND WORLD TRADE

Before embarking upon an analysis of the particular role of the UK industry and of its developing country competitors, it is first necessary to see the problem in its global context.

The technical revolution in electronics which has, as one of its by-products, generated some 'North-South' trade in products and components, is far from having run its course. The production of increasingly complex but extremely small integrated semiconductor circuits required for making 'microprocessors' or 'microcomputers' has developed with great speed (for a guide to the equally complex jargon see Appendix 2). But it lags well behind demand for current models, let alone potential demand for the more advanced versions being developed. The range of possible applications and the eventual impact on consumption and production is not at all easy to predict. The spread of the new technology is mainly governed by two opposing tendencies.

On the one hand, each successive major advance in semiconductor technology reduces the unit cost of storing and utilising knowledge. We are some way yet from a world of 'free intelligence' but we are approaching it; of the (roughly) $135bn ('000m) of world electronics output in 1979, a mere $9bn was accounted for by the 'value' of the

semiconductor input on which the industry depends. The disproportion will widen. As the price of electronic intelligence falls relative to other goods, so the scope for introducing new processes and new products incorporating it will increase. The useful life of each new product or process is also shortening.

On the other hand, the combination of rapid change and uncertainty poses difficult problems of resource allocation for both companies and societies. Companies require increasingly flexible market or planning allocation systems. Social organisation does not, however, adjust easily. Significant limits on both supply and demand are beginning to appear. There will be, for some years, a shortage of microprocessor chips because of inadequate investment (the sums required are enormous). Applications are being constrained by a lack of interest by the more conservative industrial and service sector users (because of their small size or lack of resources). Since one of the consequences of a cheapening of electronic intelligence is a cheapening of automated processes, there is a general tendency for existing activities to become less labour-intensive and the mere threat of this is generating worker resistance. There is a global scarcity, relative to demand, of programmers required to produce the software to make use of new technological advances, reflected in the rising cost of software and a corresponding disincentive to use it.

The wider issues raised above cannot be pursued in this study in any depth. But there are several broad international trends emerging in electronics which have a bearing on the problem at hand. The first relates to the international distribution of electronics production and demand. Both have so far been concentrated in the developed countries. In 1975, 82% of electronics consumption and 85% of production

were in the five leading industrialised OECD countries. Most electronics consultants and global forecasters have assumed on the basis of recent trends that this dominance will decline only gradually.[6] The major areas of likely demand growth seem likely to be in resource-rich OPEC and OECD countries, and the more substantial and rapidly growing developing countries. On the other hand, production appears to be shifting towards the Far East in general and to other countries outside the core OECD group.

Second, a shift is taking place in the composition of demand. In particular there are signs of a shift from electronic consumer goods, and communications and military equipment (if only because these sectors have already experienced the first impact of micro-electronic technology). There are now potentially greater uses in instrumentation (for use in factory automation and product testing), car electrics, and office systems. A further factor reducing the relative importance of consumer goods is the near saturation of market demand in the main Western countries (other than replacement demand) for radios and TVs and many domestic appliances. There are also important national and regional differences. US electronics has been built around defence and computer development (respectively 20% and 32% of estimated 1980 production as against 18% and 21% for the world as a whole). Western Europe's strength has been in communications equipment (32% of production, against 24% for the world as a whole), based largely upon protected, nationalised, telecommunications systems. Japanese and other Far Eastern industrial development has been overwhelmingly concentrated on consumer goods (38% of production as against 17% for the world as a whole). The rest of the world taken as a whole has seen electronics developed largely for military purposes (wholly in the Eastern bloc, China and India) and, overall,

military spending accounted for 43% of 1980 production. One might expect to see each of these patterns converge as technology is internationally diffused. Equally significant are shifts within the general product categories. For example, US demand in the 1980s for TVs and audio equipment of all kinds is expected to grow from $7.7bn to $10.25bn (in constant prices) but of 'chip-based' products from $3.35bn to $9.6bn (with particular growth in the fields of micro-ovens, games, clocks and alarms).[7] And within components there will be growth of demand for microprocessors, based on advanced LSI (Large Scale Integrated Circuit) technology rather than simpler integrated circuits.

A third factor of importance is the form of development of the world's largest companies. Hitherto, US multinationals have dominated the electronics business; notably the big computer companies (IBM, Honeywell) and those with a wider involvement in electrical engineering (ITT, Western Electronics, Xerox). Only a handful of Japanese and European companies have comparable size, (within Europe the two main companies are Philips and Siemens). The most significant development within the last few years has been the independent growth of large (US) semiconductor companies. There are seven main suppliers of a broad spectrum of 'chips' (including Texas Instruments, Intel, National Semiconductor). One of the consequences of this independent semiconductor development is that producers of electronics capital goods are coming into increasing conflict with the semiconductor firms as the former try to integrate backwards to secure their component supplies while the latter integrate forwards to obtain product outlets. This is a world in which medium-sized European or Japanese companies (let alone those in developing countries) feel very vulnerable. Philips, in Europe, has independently managed to keep up a major capability in both semiconductors and end-products.

The vulnerability of those companies and countries not at the frontier of technological development accounts for the substantial amounts in subsidies being poured into semiconductor development, notably in Japan, Britain, Germany, France, Korea and Italy, of which the Japanese VLSI (Very Large Scale Integration) programme appears the most ambitious. Those electronics companies and countries which are not able to keep up with the leaders will find themselves dependent, at least for the foreseeable future, on - mainly US - companies which are also their competitors. This is not to say that there is no scope for other producers in a world market so vast and so rapidly expanding, and responsive to entrepreneurial initiatives in exploiting all manner of new products and applications.

A final phenomenon, which is related to the last mentioned, is the growing competition between US, Japanese, European and some NIC firms which has become not a purely private matter but one with wider national interests, with implications related to defence and economic security. This competition has stimulated the development of semiconductor technology and also the maximisation of benefits from internationally organised production incorporating low labour cost developing countries. US companies are currently well ahead, followed by the Japanese (in the mid 1970s, for example, three-quarters of all employees of multinationals (mncs) in the semiconductor sector in developing countries worked for US companies). With some exceptions - Philips amongst European multinationals and Germany amongst European countries - Europe is both less technologically advanced and less internationally integrated. In these circumstances there are pressures for an active European policy with both offensive and defensive characteristics; offensive in seeking to catch up with US technology through equity participation in, or partnership with,

American firms and through (partly government sponsored) R & D; defensive in a resort to protection against competition from the USA and Japan and from developing countries (to the extent that they are seen as a vehicle for the interests of US and Japanese companies and also as rivals in their own right).

While it is possible to spot trends it is more useful to be able to explain them, and for this reason we turn more to the body of theory, such as it is.

B THE THEORY

Although this is not intended to be a theoretical study, it is necessary, as a preliminary, to review the body of theory which has been built up to explain how and why developing and developed countries trade with each other in industries subject to substantial technical change.

If valid, the propositions of such a theory should have predictive power, providing explanations of past events, and as such be a guide to policy. To the extent that they identify sources of economic gain, and distributional effects, there are inevitable normative as well as positive implications. Just as the Heckscher-Ohlin theory of comparative advantage based on factor endowments has, in a much vulgarised form, become a useful polemical tool in the hands of policy-makers seeking to rationalise freer trade in products such as garments, so 'neotechnology' hypotheses also lie behind a lot of implicit theorising by practical men.

Whilst we are aware that some recent studies[8] have attempted to incorporate the concepts of technological leads, human skills, and economies of scale in the analysis of

national comparative advantage, we have nevertheless chosen to use the product cycle theory as our starting point since it seems a more appropriate tool for a sectoral level analysis which seeks to identify the role of individual firms in technologically advanced industries. The process of 'technology transfer' between firms and industries is in fact one of the major determinants of national comparative advantage and this relationship is fully brought out where it is appropriate.

Summary of product cycle theory

The story of adaptations to trade theory to incorporate technical change is a long and detailed one but it suffices here to refer to two core concepts. One is the rate of diffusion (or conversely the 'lag' in imitation) of technical knowledge; the other is the product cycle. Under capitalism, the main economic incentive behind technical innovation by a firm is to exploit the monopoly advantages from being first in a new field. Applied internationally the monopoly advantage of a firm in one country having advance access to technology provides a rationale for trade, and a source of absolute cost advantage to the innovating nation, in a way which is exactly analogous to trade based on a natural monopoly. But the national advantage in this case is temporary. It lasts only as long as foreigners' demand for the product of the new invention outstrips the capacity of companies based in their countries to acquire the new technology and apply it themselves. Barriers to the rapid diffusion of technology may well be erected by innovators, seeking to perpetuate their monopoly through patents or other restrictive licencing arrangements. These barriers are in addition to those inherent in different levels of capacity for utilising technology as between countries.

'Imitation lags' have been identified and measured for many products and are clearly an important explanation of international trade in industries where technological innovation is significant. They are, however, notoriously difficult to measure since they require a strictly comparable product or process technology. Some work has been done on rates of technological diffusion within industrial sectors of individual countries but there is a relative lack of international data.[9]

The process of international diffusion for new products has been explained in cyclical terms. New products characteristically first appear in countries where there exist sufficient human resources and financial investment in research and development to generate innovations. Second, there is a growth phase when demand for the product is expanding rapidly and competitors are entering the field. In this phase the emphasis is on mass production and maximising sales growth. The probability is that production will be launched from inside the major consuming, advanced industrial countries, partly in order to achieve the benefits of close contact with consumer outlets, but also to take advantage of the pool of marketing and engineering skills required in the growth or mass production phase of the cycle. But as more producers, including foreign competitors, enter the field, prices fall and profits are squeezed. The innovating firm, if it cannot supersede the product with something better, then has the choice of vacating the market or moving production to a cheaper location through overseas investment or through a sub-contracting arrangement. At this stage the traditional factor cost elements in comparative advantage come into their own. Where labour costs are a significant element in the total, and transport costs are not, then a developing country which offers hospitality to mnc exporters, and has cheap compliant labour, may well be an attractive base

(even if production is relatively capital intensive). Developing country entrepreneurs could well start producing and exporting also at this stage.

This very simplified account indicates how both developed and developing countries might enjoy a comparative advantage in producing an item at different stages in its life, the former in the innovative and growth stages, the latter in the 'mature' phase. A slightly more sophisticated version of the theory would involve greater differentiation in the stage of national development. For example, it may be useful to distinguish 'early' from 'late' technological followers. The former, corresponding perhaps to Japan in much of its recent history and, now, to the most advanced NICs, or to the less technologically advanced Western countries, which have firms picking up innovations and developing them in the 'growth' phase or an early stage of 'maturity', while the remaining developing and Communist countries trail some way behind.[10]

The validity of the theory

The first question which might be asked is whether this is a rough approximation of what actually happens. Vernon concludes: 'the evidence is fairly persuasive that the product cycle had strong predictive power in the first two or three decades after World War II especially in explaining the composition of US trade and in projecting the likely patterns of foreign direct investment by US firms.[11] It is possible to point to some product areas - transistors and car radios, and, to a growing extent, cassette recorders, black and white TVs and hand-held calculators - where the cycle appears to have run through to the 'mature' phase in which some developing countries are large-scale international producers. For example,

in 1977, Hong Kong produced 40% of world radio output (50m. out of 125m. sets) and other ldcs a substantial share of the remainder. Output in Hong Kong had more than tripled in the 1970s while in the United States it was in 1977 a mere 12.5m., the USA's share of world production having fallen continuously since transistor radios were introduced in the 1950s. From having once been a leading producer, the UK has progressed to a stage of making no portable transistor radios at all. Japan, which dominated production in the 'growth phase' of the 1960s (and whose mncs now account for a large slice of current Far Eastern production) made 20m. radios in 1977, down from 32m. a decade earlier.

The speed of diffusion has been faster, and the length of the cycle shorter, for electronic components. Integrated circuits were introduced in the early 1960s as an improvement upon discrete semiconductors, and were exported a few years later by their (American) innovators. Two million pieces were internationally traded in 1967, almost all originating in the US. By 1975 the volume internationally traded was 116m. pieces; the average price had fallen, through mass production, to a small fraction of that a decade earlier, and ldcs accounted for one half of world exports (mostly after simple assembly, testing and packaging in mnc subsidiaries). In the same year 35m. pieces were exported by Singapore alone (which started exporting in 1970) and 11m. by Malaysia (which started exporting in 1973). Integrated circuits now account for two-thirds of the world semiconductor market, although the advent of microprocessors, made so far largely in the USA, is now supplementing the simpler integrated circuits (ICs) in many uses.

Clearly this is not a 'pure' product cycle case because the product technology has not become standardised although

the process of assembly has. The design process and the first two stages of chip manufacture (the making of masks and wafers) are still concentrated in the USA and the 'labour-intensive' component testing and assembly operations (wiring and encapsulation) have simply been farmed out to ldcs, (ie, 'outward processing'). Secondly, due to the technology-intensive nature of the product it is extremely difficult for domestically owned firms to emerge, although, as we shall see later, this has in fact happened in the production of more standardised ICs and in the more advanced NICs. A final example is that of the hand-held calculator. Electronic (transistorised) machines achieved a growth phase in the 1960s in which Japanese firms predominated (having displaced electromechanical calculators, which were themselves first introduced in the 1950s). But before proceeding to 'maturity', a second phase innovation occurred in 1971, based on a 'chip' incorporating the latest (Texas Instruments) large scale IC, and led by US firms. This permitted a massive expansion of sales of cheap calculators, which in turn precipitated rapidly falling prices. World sales rose from 25m. in 1974 to 50m. in 1976. Prices fell in 1977 to a quarter of the 1974 level and a tenth of the 1969 level. Mainly Japanese firms based in Hong Kong, Singapore and Malaysia have expanded at the expense of US firms (the 1971 innovator, Bowmar, went bankrupt in 1977) and, with the market largely saturated other than for replacement, the cycle has run its course. The technology is apparently now incapable of major new advances, and a major priority is to find production locations which cut the cost of assembly and packaging.

Although some examples can be cited which (more or less) fit a product cycle pattern, there are limits to the usefulness of the product cycle idea in predicting future trade patterns. This is partly a question of the level of generality and abstraction of the theory. There are

all kinds of exceptions for particular categories of goods. Take one of the relatively simple examples already quoted - calculators. The product is far from uniform and there is continuous product adaptation. Standardised calculators may now be mass-produced at low cost, but expensive, sophisticated, 'upmarket' calculators continue to be made profitably, by Texas Instruments for example in the USA. In 1976, the US share of world production was under 20% by volume, but 50% by value. Even for the basic product there is a constant stream of small product innovations (liquid crystal displays, multi-functional calculators, calculators of greater power and complexity or smaller size; different (eg solar) or better power sources). The authors have been informed, however, that six months after the introduction of the latest and most sophisticated programmable calculator, by Hewlett Packard, it was also being made in Hong Kong. All of these forms of product differentiation make the concept of a 'mature', 'standardised' product an elusive one and allow for the possibility of different production locations for slight variations of the same product. In other cases the innovators of mass producers may be able to redesign or refashion products in such a way as to prolong the early phases of the product cycle and prevent or substantially postpone the 'mature' phase from emerging. It may be that for many consumer goods the idea of a product cycle is of questionable relevance because genuine product innovation backed by R & D is but a minor component in the promotion of sales.

However, there is a more fundamental query about what the product cycle actually means in practice. Innovation not only involves introducing new products but making existing products with new or refined processes. Another way of putting the same point is to say that major product innovations occur in the making of the capital goods rather than the final consumer goods. The significance of the

'microprocessor revolution', for example, has yet to be fully assimilated but one of its undoubted implications is that many of the relatively labour-intensive techniques associated with the 'mature' products manufactured in developing countries can be greatly simplified by reducing the number of components and in some cases by automating the production process. This has implications far outside the list of products grouped under the 'electrical goods' heading, but consumer electronics and components are probably particularly susceptible to these changes. Already we are seeing in the assembly of colour TVs (though not specifically because of microprocessors) a progression to highly automated assembly, initially in Japan and now in Europe, which is reversing an otherwise predictable drift of the industry to low labour cost manufacturers in South East Asia. It may be that, in the manner of electronic calculators based on integrated circuits, the new process innovations will themselves 'mature' and diffuse. But one factor working in the opposite direction is the influence of economies of scale. In the automated manufacture of colour TVs (as of motor cars) there are significant scale economies which are a major barrier to entry for new producers and a source of comparative advantage for those already operating at large-scale. Established producers such as the Japanese colour TV firms (11.5m. sets per annum are produced in Japan) are also able to derive other advantages from large-scale production, such as improved quality control and generation of sufficient surpluses to finance product adaptations. Even where process innovation does not invalidate the concept of a product cycle, it may, for a large number of products, remove from it the current advantage of low wage suppliers in the 'mature' phase by creating the possibility of eliminating most of the labour content of manufacture. (This is not of course a concern solely for electrical goods; something similar has happened in some textile processes, notably jute manufacture).

Thus, conceivably, developing countries may find that there are relatively few manufacturing processes for which wage differentials are a decisive factor in determining the international division of production.

This is caused in part by automation of production which reduces the proportion of direct labour cost to total manufacturing cost. Another reason is that the introduction of major product and process innovations in traditional mass production industries requires extensive research, development and investment expenditure, with the result that the industry often becomes highly capital-intensive (ie saving in capital per unit of output as the ratio of capital to output, K/O, falls but an increase per worker employed, as K/L, rises) after improvements are introduced. As Rada suggests, 'In this way more and more industries cross the barrier into the high technology category where design and quality become essential to the acceptability of products'.[12] The effect of all this is not only to facilitate the survival in the developed countries of industries which were potentially transferable to ldcs but also to undermine those relatively labour-intensive industries already in developing countries. There is a possibility in industries such as clothing of a return of parts of the production process to the developed countries.

There is, on the other hand, a possibility that the cycle may be losing its predictability in a different way and one which gives lower labour cost countries a greater role in the international division of production, particularly in the electronics sector. With time, and growing size, multinational companies can be expected to acquire a global perspective and become fully aware of the characteristics of all main markets and possible production locations. Their decision on where to introduce new products or

whether to mass produce them could in such circumstances depend less on close proximity to the final market and more on the cost of production at each stage of a new product's life. Thus not just 'mature' but also new products might well be launched from a production base in a developing country or, at least, bits of them sub-contracted there. It is doubtful if this kind of behaviour - Vernon called it 'global scanning' is yet common. But there are examples. The production of connectors and inter-connectors is a key element in microprocessor assemblies. There are as yet only six plants in the world but of these two are in South East Asia, the latest currently being built by Dupont in Singapore. To take another example, Fairchild Semi-Conductor (Hong Kong) started producing semiconductor discs in Hong Kong shortly after they were introduced in the firm's US parent. Nor do ldcs necessarily have a passive role as mnc subsidiaries or licencees. There is a growing number of (non-Japanese) Asian mncs with their own capacity for innovation. Thus 'firms operating in the rapidly industrialising group - in countries such as Mexico, Brazil, India and Korea - are demonstrating a considerable capacity for producing innovations that respond to the special conditions of their own economies'.[13] In other cases, indigenous ldc firms are sufficiently advanced in technological capacity and marketing skills to introduce new products and launch them in Western markets. These are, for the most part, adaptations of existing ideas rather than totally new products and are unlikely to incorporate an indigenous component technology. Nonetheless, this pattern may contain the seeds of a growth comparable to that which has - in electronics - taken the leading Japanese firms from being mere imitators and assemblers of 'mature' products to being technological innovators second only to a few US multinationals.

A final point is that international investment decisions by multinational companies or cost differences between different producing locations are influenced by a great many factors amongst which markets, determined real wage rates, or proximity to consumers, may be relatively unimportant. There is intense competition between many countries to attract internationally mobile capital and 'offshore' production using a variety of tax reliefs and subsidies or other forms of artificial inducement. Export processing zones are the most comprehensive form of 'packaged' incentives to foreign investors and have played a major part in attracting electronics production to South East Asia. But developed countries themselves increasingly engage in such practices: for instance the Republic of Ireland and the proposed incentive zones in the UK and the USA. In a world such as this the evolutionary pattern of trade in new products is likely to be very unpredictable.

Drawing these strands together it seems clear that if the theoretical framework of the product cycle retains any predictive force it does so only for some products and has to be hedged about with a good many qualifications.

Policy prescriptions

How do we now abstract from this rather messy picture of the way the world seems to work, to a set of policy prescriptions for a particular country - the UK? Some British-based companies are, in fields such as communications and medical equipment, quite close to the technological frontier, but at the same time the electrical engineering industry also has a substantial stock of assets, human and physical, invested in the production of what are now 'mature' products, which could increasingly be produced

more cheaply in developing countries. It could be argued that it is not the job of governments to do other than create a general climate favourable to technical advance and entrepreneurship and to leave their specific development to 'the market' (used here in a loose way to refer to the operations of the private sector dominated by a small number of large firms and with numerous departures from perfect competition). Countries operating, apparently successfully, at different stages of the product cycle - the USA, Germany, Hong Kong - have governments which have allowed their firms to develop their potential with minimal interference (albeit in the case of the USA with the help of a massive injection of government money into R & D for space and military purposes). Others - Japan, France and most of the NICs - have had less passive governments. British governments have been less consistent but under governments of both parties there has been intervention in support of 'infant' industry electronics component and capital goods firms, and also protection of more established, mainly consumer, electrical goods manufacturers coming under pressure from producers in Japan and amongst the NICs.

Given a commitment by governments to intervene, the policy prescriptions from the theory are not all that clear. National comparative advantage is not securely founded on the rock of fixed resource and factor endowments but on the shifting sands of technical innovation and consumer fashion, on the corporate strategies of a small number of multinational companies, and on the packages of incentives which governments use to bribe these companies to locate in their country. The main problem lies in defining where, in general terms and in the long run, the British electrical engineering industry - and particularly the expanding area of electronics - 'fit in' as between

the advanced technology 'leaders' and the NIC 'followers'. If it were possible to opt for ideal solutions, the choice would almost certainly lie with those products which, in product cycle terms, are in the innovation and growth phase where prices and profits are highest and there is the possibility of launching into a virtuous circle of high rates of innovation and investment leading to rapid industrial growth and in turn to greater investment in growth industries. The evidence suggests that, considered cross-sectionally, those British industries which do relatively well in international trade are those for which R & D (leading to innovation) is important.[14] But industrial innovation is also an activity in which British performance, over time, has been shown to be slipping badly; R & D expenditure has been both increasingly inadequate in aggregate, as well as misdirected.[15] Scibberas has shown, for example, (Table 1) that Britain is not only well behind Germany and Japan as an innovator in consumer electronics and electronic components but, at the margin, the gap is growing wider especially in relation to Japan.[16] He observes 'between 1970 and 1978 the US accounted for 10 and Japan for 2 of the 13 major semiconductor process and product innovations... No UK firms were represented at all.. Moreover, of these 13 innovations only four were first introduced into the UK by indigenous firms. With each new wave of technical change UK performance has worsened'.

One response is to try to restore a comparative advantage in the more 'advanced' manufactured goods, reversing the decline in relative technological performance by improving the circumstances under which higher R & D is possible and is then commercially applied. This objective has long been proclaimed but concrete results are difficult to identify. Another, radically different, approach is to seek to make an economically efficient virtue out of

growing technological backwardness and to adjust to the role of a technological follower and relatively low wage competitor in the production of 'mature' goods. As we shall see below, the colour TV industry has, in part, taken this approach, operating as a 'low wage' producer for the EEC. But 'this may be even less of a 'solution' than trying to maintain technology competition since there are many third world countries who can beat the UK in that league'.[17]

Table 1: Average annual growth rates 1963-1976 and 1976 shares of patenting and licencing in the USA

Country	Electronic components		Radio and television	
	1976 share	Average p.a. growth rate	1976 share	Average p.a. growth rate
Japan	6	145	10	82
Germany	5	16	5	19
UK	4	6	4	16.9

Source: E. Sciberras, *op. cit.*, based on figures prepared for SPRU by the Office of Technology Assessment and Forecast, US Patent and Trademark Office.

The choices may not be as black and white as we have depicted them. There are shades of grey as well. Balassa's concept of 'stages of comparative advantage' is designed to explain the position of 'intermediate' economies. Another classification distinguishes 'early' technology followers and 'late' followers. The first category could identify a possible role for Britain assimilating, through inward foreign investment or links between British and US (or Japanese) firms, as much as possible of the latest technologies while vacating the most standardised labour-intensive processes to the 'late' followers.

One problem with this kind of industrial strategy is the observable shortening over time of the 'diffusion lag'. Vernon and Davidson have shown that production of over a third of new products by 57 US-based mncs was transferred to overseas subsidiaries within a year after introduction in the USA in the 1971-75 period as against 10% in the 1950s and 26% in the 1960s.[18] This increasingly rapid diffusion gives 'early followers' potentially earlier access to new technology, but it also compresses the length of the product cycle as a whole. It can be observed, for example, that within a few years of their introduction, production of new products - such as hand-held games and video recorders - has spread to firms in Far Eastern NICs, and, in some cases, even less sophisticated ldcs - without ever having been started in Britain (or most of Western Europe). In the circumstances of a shortening product cycle it becomes extremely difficult to define what 'adjustment' is supposed to mean for the British economy (out of what? into what?).

The speed with which new technologies are diffused presents difficult enough problems of adjustment for firms, evidenced by the inability of Britain's leading consumer electronics firm, Thorn-EMI, to diversify successfully away from its dependence on TVs into medical electronics.

Where responsibility for choice is assumed in part by governments, through external trade or domestic industry policy, there are other problems. There are obvious institutional difficulties which arise from government bureaucracies trying to operate in a high risk, rapidly changing, environment, where 'picking winners' requires rapid decision-making and a willingness to retreat quickly from costly mistakes. But there are problems also in identifying the 'losers' - those sectors from which it is necessary to withdraw and redeploy resources. One is the reversibility, in some instances, of comparative advantage through process innovation. British (and other) European colour TV firms (backed by their governments) are currently investing in automation to prevent the otherwise inevitable drift of production to NICs. But in other instances, and possibly even in these, attempts to 'recapture' comparative advantage may prove fruitless or, at least, a suboptimal use of investment. Another question is whether a high technology industry is greater than the sum of its parts. The product cycle theory is, significantly, concerned with independent disconnected technological advances. In the real world, there are externalities; skilled labour or technologists trained to work for one firm on one problem enlarge the pool of expertise potentially available to be used by others. The inputs of one firm provide a market for the output of goods and services of other, local, firms. An interventionist British government would have, for example, to take a view on how a trade-induced contraction of consumer electronics could affect component suppliers and how this in turn would affect other UK users of components. Even that supremely non-interventionist of all governments, the authorities in Hong Kong, have been moved to criticise and to try to improve the way in which the electronics industry has grown up, lacking integration and largely consisting of a random collection of assembly operations unrelated to each other and with minimal backward linkages into R & D

activities.[19] Enough has been said, however, to make the point that decisions on whether to assist 'infant' or 'senile' electronics industries will rarely be easy or straightforward quite apart from any political special pleading (which also enters the argument).

Finally, where governments are involved in policy-making, positions will necessarily be defined in terms of national interests. The neo-technology theories of trade are, by contrast, essentially theories of how private firms behave, with subsidiary inferences drawn about how this affects nations. Where firms are genuinely transnational the national economic interest, as seen by governments, is bound to be elusive. Suppose we take as our starting point that 'central concern of UK government policy should be the restoration of international competitiveness if there is to be a viable UK electronics industry in the future'.[20] Does the 'viable UK industry' consist of British-owned firms operating in Britain, or British-owned firms operating overseas, or foreign-owned firms operating in Britain, or a combination of these? The answer will depend in large measure on what are the fundamental objectives of government policy - higher output, employment, or whatever. But all governments have a mercantilist component in their economic policy, the more so in this case as electronics (and all electrical engineering) is at the heart of defence (and most industrial) technology. It is not immediately obvious, for example, whether Japanese (or for that matter Taiwanese and Korean) investment in the British television industry should be considered part of a contribution to making the UK industry 'viable' (the British government and the manufacturers' association appear to think so, but there have been dissenting views). Alternatively, it is also unclear whether we should regard as 'successful' adjustment (from a UK standpoint) the investment by British companies in 'offshore processing' in developing countries.

The considerations sketched above suggest some reasons why policy-makers at a national level may be unwilling to accept passively the working out of the product cycle and may want to try to influence it. They also suggest why this intervention may be problematic. One policy area which we shall be pursuing in detail is intervention to nullify the comparative advantage which ldcs have in some products, and to this we now turn.

C. DEVELOPING COUNTRIES AS 'LOW WAGE' COMPETITORS

Trends

Although this study is not primarily concerned with the details of developments in ldcs it is necessary to give an overview of present and likely future sources of competition and of the mechanisms by which technology is transmitted to these countries and their exports promoted. OECD imports of 'electrical machinery' from developing country NICs totalled $5.0bn. in 1978 (see Table 2), accounting for approximately 11% of imports and 5% of consumption in the OECD group as a whole. In 1970, by contrast, the total was $0.7bn., just over 1% of OECD consumption, and in 1968 a mere $0.25bn. The growth has been prodigious and although these figures may give a somewhat flattering picture of the real value of these exports from ldcs (since a substantial slice - perhaps well over half - of the final value is accounted for by components produced in OECD countries), the electrical goods sector has made a substantial contribution to ldc manufactured export growth. The total value of electrical goods exported by ldcs may, in a wider sense, by under-estimated since the rather peculiar trade classification conventions have the effect of excluding calculators,

Table 2: OECD imports SITC 72 (electrical machinery apparatus and appliances), US $bn.

		1970	1974	1976	1978
(1)	Total OECD	8.1	28.9	36.6	47.5
(2)	Japan	0.24	3.2	5.3	8.85
(3)	ldcs	na	3.5	4.6	na
(4)	NICs[a]	0.7	3.5	4.3	5.0*
(5)	Brazil	0.003	na	0.1	0.2
(6)	Hong Kong	na	0.5	0.7	0.9
(7)	Eastern bloc	0.1	0.3	0.3	0.4*

Source: OECD Trade statistics Series B and Annex table 1 in 'The impact of the Newly Industrialising Countries', 1979.

Notes: * 1977 figures.
[a] Defined by OECD as Brazil, Greece, Hong Kong, Korea, Mexico, Portugal, Singapore, Spain, Taiwan and Yugoslavia.

Table 3: Product composition of NIC electrical engineering exports, 1978 (value in US $m.)

SITC Code		Korea	Hong Kong	Singapore	Malaysia	Philippines*	Yugoslavia*	Mexico[a]	Brazil	India	Argentina
72	Total electrical machinery	1252.2	1228.9	1568.4	333.2	25.9	417.0	53.3	346.5	102.7	47.4
722.1	Electric power machinery	42.2	51.4	52.7	174.4	breakdown na	59.7	11.6	48.1	25.3	11.0
722.2	Switchgear, etc	38.9		62.8			59.3				
TOTAL	722	81.1	51.4	115.5	175.2		119.0	11.6	48.1	25.3	11.0
723.1	Insulated wire and cable	45.4					81.8	3.6		20.3	
724.1	Television receivers	230.6		189.7							
724.2	Radio receivers	182.4	503.0	241.3	411.6				100.0		
724.9	Other telecom. equip.	201.2	92.4	37.1			43.5	7.6			
TOTAL	724	614.2	600.7	468.1	496.2		55.6	7.7	131.6		
725	Domestic electrical appliances		172.6	50.9							
729.1	Batteries and accumulators			58.6			35.8				
729.3	Electronic components	371.7	299.5	791.8	90.4			10.9	39.3	27.3	15.9
729.4	Automotive electrical equipment								55.4		
729.9	Other elec. machinery and appliances	54.3	36.2	30.5				11.5			
TOTAL	729	487.9	335.7	880.9	104.8		35.8	27.9	94.7	27.3	15.9

Source: *UN Yearbook of International Trade Statistics.* There are many 'gaps' in the table because detailed product breakdowns are not available for each country.

Notes: * 1977 figures.

[a] Mexico breakdown as given in UN statistics - these figures understate actual value due to electronics exports made across UN border in the Northern Mexico FTZ.

electronic games and some other items. Within electrical engineering the most important subproducts (Tables 3 and 4), at least in the 1970-76 period, were components (transistors and valves) and radios. But there was also a surprisingly high level and growth of ldc exports to developed countries of less predictable items such as switchgear and power equipment. Such are the time lags in data collection in relation to changes in the industry that there is little record of new categories of goods which were of relatively minor importance in the mid-1970s; TVs, tape recorders and new generations of components.

The four Far Eastern NICs (Hong Kong, Taiwan, Korea, and Singapore) dominate ldcs' manufactured export trade in electrical goods, with only Mexico, of the remainder, exporting comparable amounts (Table 5). Such is the momentum of the export drive of the Far Eastern NICs that, despite the emergence of some new, rapidly growing, sources - Malaysia, Thailand and Indonesia - the share of the four NICs has increased during the 1970s to almost 80%. There has been a relatively poor performance by some other ldcs which were early in the field. India exported roughly the same value of electrical goods as Korea in 1967 but a tenth a decade later. Argentina exported more of these goods in 1967 than Malaysia but less than a tenth a decade later. Yugoslavia (usually classified as an ldc) was second only to Hong Kong in 1967 but a decade later ranked seventh among ldc exporters of electrical goods. The differences owe something to overall differences in export performance between the countries. More significant is a difference in product composition. The rapid growers have specialised in consumer electronics and components, while the slow growers have more varied exports including a substantial share of electro-mechanical equipment. Underlying this distinction is a question of ownership and the role of mncs in international trade in consumer electronics and components.

Table 4: Products which contributed most to ldc manufactured exports to developed market economies, 1970-1976

SITC item		Growth: 1976 value as multiple of 1970 value	Value increment 1976 value less 1970 value ($m)	Ranking in top 50 products of all kinds	Share of ldcs in in developed market economy imports	
					1970	1976
7293	(transistor/valves)	7.8	1065.5	3	12	27
7242	(radio receivers)	6.9	561.1	6	11	64
7249	(other telecommunication equipment)	9.5	444.2	7	3	9
7222	(switchgear)	11.1	200.3	22	1	6
7299	(other electrical machinery)	4.7	185.3	26	5	10
7142	(calculating machines, computers)	26.2	183.8	29	1	15
7221	(electrical power machinery)	9.3	182.2	30	2	7
8911	(sound recorders)	40.8	165.8	35	0	7
7250	(domestic electrical equipment)	14.7	134.2	39	1	4
7149	(office machinery nes)	3.4	114.6	42	3	6
7241	(TVs)	6.0	98.8	45	3	4

Source: UNCTAD Secretariat, 'Dynamic products in the exports of manufactured goods from developing to developed market economy countries 1970-76'.

Table 5: Growth of exports of electrical machinery from developing countries (SITC 72), US $m.

	1967	1973	1976	1978	Average annual growth 1967-73 (%)	Output growth 1976-78 (%)
(1) Singapore	18.5	387.8	885.2	1568.4	66	77.2
(2) Taiwan	38.6	741.8	1194.7	1487.0*	64	24.5
(3) Korea	7.4	312.5	805.6	1252.2	87	55.4
(4) Hong Kong	108.9	583.7	990.8	1228.9	32	24.0
(5) Mexico[a]	13.6[a]	(410.5)	(723.6)	na	76	na
(6) Malaysia	2.4	11.3	205.4	524.7	29	155.45
(7) Yugoslavia	80.8	240.5	351.6	417.0*	20	18.6
(8) Brazil	5.4	87.1	202.7	346.5	59	70.9
(9) Thailand	0.4	1.8	48.0	64.8*	29	35.0
(10) Argentina	2.9	32.9	37.0	47.4*	50	28.1
(11) Indonesia	-	-	31.6	32.6*	-	3.2
(12) Philippines	-	2.2**	6.4	25.9	-	304.7
TOTAL	285.7	2842.3	5567.9	7098.1	-	27.5
(1-4) as % of total	60.7	71.3	69.6	78.0	-	-

Source: *UN Yearbook of International Trade Statistics, 1978* and P. Plesch, 'Developing countries' exports of electronics and electrical engineering products', *World Bank Working Draft*, table 5.

Notes: * 1977.
** 1974.
[a] Mexican exports have been modified to reflect border assembly industries. Figures in brackets are estimates.

Multinational companies

Mncs are involved in ldc exports of electrical goods in a variety of ways. The most obvious is through wholly owned subsidiaries. But mncs are equally likely to operate a form of licencing arrangement in which a local company produces according to the restrictive terms of a patent or in a subcontracting capacity or under a recognised trademark. There are types of partial foreign ownership, joint ventures for example, and ways of exercising indirect control, through loans, management contracts or agreements covering the supply of components. The precise form of the relationship will vary from country to country and product to product. In general the control exercised by the parent company over the electronic component exports of ldcs is almost total and is usually through subsidiaries, while the export of fully assembled consumer electronics is more likely to be through a licencing arrangement and give greater scope for ldc entrepreneurship. Perhaps the most simple and dependent relationship is that of the 'world market factory', a wholly owned subsidiary, almost certainly sited in a tariff-free, tax-free (and preferably, union-free) zone, which carries out one or more sub-assembly operations of a specialised kind for export to supply the company's other subsidiaries. Many of the South East Asian semiconductor plants are of this character as are the 'maquiladora' border plants in Mexico which receive tariff relief for reimportation back to the USA. Much more independent are the large indigenous Asian firms, like Timco in Hong Kong or Samsung in Korea. These derive part of their income from manufacturing under licence for mncs or in a joint venture relationship. But an increasing share of their earnings comes from products of their own design sold under their own brand names in the Asian region or in Western countries through independent importers or direct to retail stores.

Because of the complexity of the links between mncs and local producers, the measured share of foreign companies considerably understates their true influence, but such figures as exist are nonetheless of some interest. In Singapore, which, with Korea, saw the most rapid sustained expansion in the 1970s, almost 100% of electrical goods exports were by locally based foreign companies attracted by incentives including five year tax holidays and an 'open door' policy on investments. The main investors have been American firms in micro-assembly and component manufacture - Texas Instruments, National Semiconductor and Fairchild. But final products are important too. Philips, for example, has a whole complex of plants there making cassette recorders, radios, TVs, telephone equipment, and household electrical appliances. General Electric makes radios, components, phonograph cartridges, electric motors and household appliances. Japanese companies (led by Hitachi and Sanyo) are second to US firms. Hong Kong has less penetration by foreign companies, but electronics mncs accounted for 30% of all direct foreign investment in the colony in the 1970s (while electronics products contributed 15% of incremental exports). A survey of the Hong Kong industry in 1978 showed that 67 out of 768 registered electronics factories were wholly or partly foreign owned, but these accounted for 41% of the workforce.[21] In Korea foreign mncs account for only 15% of manufactured exports as a whole but 75% of electronics exports.[22] In Taiwan, 46% of all foreign investment in the last 25 years has been in 'electronics and electrical appliances'.[23] By contrast, countries like India which impose restrictions on foreign ownership and on the free flow of imported inputs have made a negligible impact on world trade; only 5% of India's engineering exports are of electronics goods. However, the Indian industry's self-reliance and greater concentration on electrical engineering activities as opposed to electronics products has paid dividends in other ways.

For example, India is now a significant second-rank exporter of heavy electrical equipment such as 'turn key' power stations, mainly through the Bharat Heavy Electricals Company. The company has been awarded significant contracts in 'third markets' such as Libya, Saudi Arabia, Malaysia and New Zealand.[24] Nevertheless, India has also recognised the potential benefits of export-orientated development and is now trying to enter the field by providing 'offshore processing' facilities of a type similar to those available in free trade zones in South East Asia.

The future

Predictions of future developments in trade in electronics goods, and the role of ldcs within it, are far more speculative than in most other areas. Since demand for the products is usually income-elastic, trade is generally highly sensitive to the level of overall demand in the richer Western countries. The nature of technological innovation is also difficult to predict, in particular the extent to which processes carried out in ldcs can be automated. But exports of the simpler kind of electrical goods are almost certain to be a major feature of any expansion of manufactured exports by ldcs. They attract fewer trade barriers than goods like textiles (since many Western companies have a strong interest in keeping trade free). Their production uses virtually no energy. They provide employment at little resource cost (though that is not to ignore the substantial criticisms which have been made of the conditions in which the, mainly female, workers are employed). For these reasons some of the poorest ldcs, such as Bangladesh and Indonesia, are bidding, apparently with some success, for foreign investment. The more advanced NICs have openly declared ambitions on a grander scale. Korean official forecasts (which have a habit of being right) anticipate

electronics exports of $3bn. in 1981, 6% of world trade. Taiwan is keeping roughly abreast of Korea and Hong Kong and expects to reach 2.5% of the world market by 1985. Based on extrapolation from the past, and what is known of planned developments, the World Bank expects 20% real growth over the period 1976 to 1986.[25] On this basis, electrical goods would by 1986 account for a third of ldc manufactured exports and 40% at the margin. These estimates are crude but even if partly true they suggest a substantial addition to world supply.

The Far Eastern NICs

The main impact will be made by the four Far Eastern NICs (Hong Kong, Singapore, Taiwan, and South Korea) and we shall briefly review the main developments taking place there, firstly, in order to indicate the likely nature of their competition and secondly, to see to what extent it is feasible for new ldc exporters to envisage (on the basis of NIC experience) an evolution towards a less technologically dependent, more sophisticated kind of industry than that thrown up in the early stages of export. All the four main Asian NICs have several inter-related objectives: to relate component production more to local needs; to achieve higher value added, higher quality and more diversity in final products; to raise the indigenous technological level of local industry; to reduce labour intensity; to strengthen the position of local firms and brands in world markets. The NICs are trying to reduce their dependence on imported components, which are often in short supply (and may be deliberately withheld in some instances) and at the same time reduce their role as exporters of specialised semiconductors. Korea how has 85% local components in its colour TVs and has cut the share of components in the total value of electronics exports

from over 80% in 1970 to well under 50%.[26] Less organised Hong Kong is more dependent in both respects though increasingly complex subcircuits are being developed locally. It was recorded early in 1980 that Hong Kong firms were making their own cassette recorder mechanisms rather than importing them from Japan.[27] Taiwan, where originally resistors were only made in US subsidiaries, now has 60 local firms making these components to ever greater precision. The NICs are all seeking to develop their own integrated circuit technology instead of buying it from overseas or merely carrying out local assembly and testing. A Hong Kong firm, for example, (Micro-electronics Ltd.) is making silicon wafers for ICs and a crucial technology - diffusion - is being developed locally. Two Taiwanese firms are making small ICs for use as memory chips in a wide variety of local consumer goods applications. The Korean government is making a big effort in semiconductor technology development backed by the World Bank.

Another objective is to diversify into new, higher value-added, products (anticipating that the traditional consumer electronics markets will soon be saturated or difficult to penetrate because of protectionist barriers). Both Korea and Taiwan are trying to develop (by acquiring foreign technology) the newest video products (ahead of the UK). Korea plans to produce video disc players (but firms have been baulked from acquiring Japanese video tape recorder technology by the refusal of the Japanese to sell).[29] A Taiwanese firm is investing to produce video cassettes, backed by government-financed R & D. Both of these countries and also Singapore and Hong Kong now have a wide range of firms producing more sophisticated consumer products than the traditional black and white televisions and transistor radios; these include car radios and cassettes, composite 3 in 1 or 4 in 1 radio/TV/cassette combinations, electronic smoke detectors, pen watches, microwave ovens. Non-consumer

items are being produced increasingly too; testing equipment, control devices, micro-computers. One of the three top Korean firms, Gold Star, has invested heavily in developing electronic telephone exchanges (based on Siemens technology). Singapore firms (and increasingly India, with government backing) appear to be trying to carve out a market share in the field of 'offshore' softwear services for computing and electronics firms. Softwear may eventually be more profitable than manufacturing but it also raises questions about how far the NICs can advance into more than simple conversion of softwear and how they will be able to withstand increased competition from firms in developed countries which are increasingly adopting language simplification and automation. In carrying out this kind of restructuring there is a difference in approach between the more 'organised' approach of the Koreans and the entrepreneurial style of Hong Kong, with the other two countries somewhere between these extremes. Korean firms, with government backing, plan ahead and then embark on large-scale production of relatively new but well-defined product areas, with as much local technological and material content as possible. Hong Kong's flexible and adaptive businessmen, on the other hand, have been more successful in anticipating and responding to fashion shifts but, in general, less noted for building up the supporting infrastructure and linkages for large-scale industrial production ('speculators rather than investors' as they have been described).[29]

Associated with these objectives of greater technological self-reliance and of more sophisticated, high value-added exports, is a commitment to greater R & D. In part this is being accomplished with government backing both directly (in Korea and Taiwan) and indirectly through systematic provision of education to create highly trained manpower

(notably Singapore). But it also derives support from the emergence of home-grown Asian multinationals with their own R & D divisions. One Hong Kong multinational for example (Conic) has an R & D subsidiary with a branch in Japan. Another (Timco) is designing and making automatic language translators and sophisticated new electric toys; its operations are now characterised as 'less labour intensive than technology intensive'.[30] The biggest Taiwanese electronics company Ta-tung now has a large R & D section and employs one scientist for every 20 employees. Perhaps the most successful attempt to combine low wage costs with high technology is the wrist-watch industry which has been particularly successful in Hong Kong.

While it is possible to produce anecdotal evidence that a new and more sophisticated electronics sector is emerging in the Far Eastern NICs, there remain doubts as to how far-reaching the changes are. The head of Korea's electronics industry association thinks 'Korea is trailing 15 years behind Japan' (it is also probably a little behind Taiwan).[31] It may not even be closing the gap on Japan; R & D expenditure is measured at only 1.3% of sales revenue, a third of Japanese levels. Nor are all the modernising objectives necessarily consistent. New generations of products require new components making obsolescent those painfully developed locally. New products also require international commercial alliances which could weaken the independent capacity of local firms. But these countries now have little choice but to press on. Their economies have reached a point where there is strong pressure for reduced labour intensity in industry as a result of higher wages and labour scarcity and competition from lower wage economies. Increasingly, labour-intensive operations are being either automated, abandoned or subcontracted to Malaysia, Thailand

and the Philippines. In the case of Hong Kong there is a large and growing but discrete subcontracting trade with China. And whatever anxiety there may be about the speed with which this transformation can be accomplished, there is little doubt that the overall historical experience of electronics export has been favourable and an encouragement to others to follow, thus (Sanjaya Lall on Singapore): 'all in all the Singapore electronics industry has been a great success. It has created substantial employment, has added to local skills and foreign exchange earnings and seems likely to stay on the island despite rising costs'.[32]

The re-location of labour-intensive manufacture from the four main Far Eastern NICs to the poorer countries of Asia (so far almost entirely South East rather than South Asia) reinforces a tendency already observable for Japanese and US multinationals to prefer these countries for new investment in labour-intensive activities. Electronics exports from the Philippines rose from nothing in 1972 to $125m. in 1977, almost entirely in the form of semiconductors assembled by the (20,000) women who work for mncs in export processing zones.[33] This primitive form of international specialisation is now being supplemented by consumer products and built upon by Filipino-owned and -managed export companies. A large-scale educational programme has been designed to assist in creating a substantial electronics industry in the long term. Malaysia has already moved quite some way along the same road. One plant will start to export colour and monochrome TVs this year in addition to others exporting calculators and radio equipment. The electrical goods industry employed 55,000 in 1978 making goods mainly for export. Other interesting developments in the 1980s will be in China, India and Brazil all of which have a great perceived need for foreign exchange, ambition to develop export-orientated electronics industries,

and a substantial pool of skilled manpower hitherto engaged in developing electronics for defence or import-substituting industrialisation.[34]

Whatever strides in international trade in electronics are made by the NICs and by other ldcs, the fact remains, however, that they will continue to be very dependent on a small number of multinational companies for the supply of the most technologically advanced components and on these and other Western companies for marketing their output. Such technological dependence by no means eliminates the gains from trade, and it is a feature shared to an increasing extent by the 'technological followers' amongst the developed countries, such as Britain, to which we now turn.

The British Electrical Engineering and Electronics Industries

A. MAIN CHARACTERISTICS

The UK electrical engineering industry in total accounts for just over 10% (10.3% in 1979) of manufacturing employment, approximately 9.3% of net output (value added) and 7.3% of gross output (the low figure for gross output relative to employment reflects the relatively labour-intensive nature of the industry (see Table 6). The 'weight' of electronics within the electrical goods sector is roughly 50% (1977 figures, based on an aggregate total for MLH items 363 to 367, therefore a very rough approximation; see Appendices 1 and 2). The share of electronics, on this basis, has increased from 25% in 1963, but this underestimates the shift from electromechanical to electronics production since there is a shift taking place within the main categories as well as between them (and outside them; it is not possible, for example, to record the large increase in employment in 'software', classified under 'research, professional and scientific services').

Taking a long view of employment changes (Table 6), the sector as a whole has lost 80,000 workers in the 1970s (1969-79), having gained 150,000 in the 1960s (1959-69). Productivity continued to increase in the 1970s much as before, while output did not, mainly because of slower growth but also because of some overall deterioration in the trade balance in electrical goods. The main electronics categories contributed almost all of the increase in the 1960s

Table 6: Structural characteristics of electrical engineering industry[a]

	Gross output (£m)				Value added (£m) (net output)				Employment			
	1963	1970	1977	1977 Index	1963	1970	1977	1977 Index	1963	1970	1977	1963-77 % change
All manufactures	27,772.0	47,359.6	138,089.6		10,820.0	18,532.1	52,534.0		7,865.0	8,033.3	7,455.9	(5.2)
Electrical engineering	1,890.0	3,597.8	10,573.2	100.0	954.4	1,638.6	4,920.8	100.0	762.9	773.1	744.2	(2.5)
Electrical machinery	486.0	661.6	1,980.4	18.7	245.4	301.8	958.1	19.5	219.5	149.7	142.1	(35.3)
Insulated wires and cables	227.0	457.3	978.1	9.3	79.8	141.3	343.2	7.0	52.9	50.2	44.6	(15.7)
Telegraph and telephone apparatus and equipment	152.8	294.9	825.5	7.8	94.9	151.8	526.1	10.7	87.1	93.2	91.4	+4.9
Radio and electronic components	149.1	450.2	1,320.0	12.5	93.3	251.2	696.8	14.2	84.3	126.2	120.9	+43.4
Broadcast receiving equip.[b]	173.6	360.0	630.3	6.0	73.9	144.8	274.2	5.6	53.5	52.0	45.8	(14.4)
Electronic computers	40.3	169.2	1,304.1	12.3	20.5	65.9	456.8	9.3	10.4	22.9	33.5	+222.1
Radio/radar and electronic capital goods	181.2	365.4	1,275.5	12.0	106.2	198.4	710.3	14.4	75.1	83.1	98.2	+30.76
Electrical appliances for domestic use	213.2	312.0	880.0	8.3	104.5	134.0	318.3	6.5	71.9	65.0	61.6	(14.3)
Electrical equipment for motor vehicles, cycles and aircraft		176.3*	427.8	4.0		91.3*	232.0	4.7		40.1*	48.4	+20.7
Primary and secondary batteries	266.7	131.4*	304.5	2.9	135.9	63.7*	155.3	3.2	108.3	19.1*	18.7	(2.1)
Lamps, light fittings and accessories		232.3*	501.8	4.7		118.4*	249.7*	5.1		51.6*	45.8	(11.2)

Source: *Business Monitor* PA1000, Table 1, 1977, 1975. Census of Production, summary tables, 1970, C.154.

Notes: * 1972 figures.
[a] The industry is ORDER IX in official statistics and covers MLH 361-369.
[b] This category includes gramophone records and tape recordings.

and lost only 20,000 jobs in the 1970s (with no deterioration at all for electronics capital goods, and components). There are, therefore, major structural changes taking place which mask the, relatively, much smaller changes in occupational structure resulting from trade adjustment.

The industry compared

It is instructive to compare the overall shape and size of the UK electronics industry with that of other European countries. The value of production is less than half that of the German and about 70% of the French (Tables 7a and 7b). But this no more than reflects the fact that the UK economy is significantly smaller than these. As a share of GNP, the UK electronics industry is roughly comparable to the German, larger than the French (though the French electronics industry is increasing very rapidly) and substantially bigger than the Italian. Subsectoral variations are more revealing. The UK (and French) industry is relatively strong in communications (mainly radar and navigational aides, also radio communications and public broadcasting) and the German particularly weak, reflecting, probably, the importance of defence industries in the UK and France (and the influence of the BBC in broadcasting). The UK computer industry is also relatively strong in European terms. One major area of weakness for the UK (and also France and Italy) is consumer electronics, where Germany accounts for over 40% of all European production. The deficiency is mainly in radio and other audio equipment. The UK radio, and related, industries have all but disappeared. Another area of weakness is telecommunications, particularly as compared to France and Italy, where investment in nationally protected telephone equipment is on a large scale. Amongst more specialised products, UK industry has been particularly deficient in data processing other than computers,

Table 7a: Consolidated summary of West European production (US $m.)

Regions	Computer systems		Control and instrumentation		Communications		Tele-communications		Consumer		Components		Totals	
	1977	1980	1977	1980	1977	1980	1977	1980	1977	1980	1977	1980	1977	1980
France	1,157	1,988	604	1,017	1,790	3,937	2,048	4,105	998	1,017	1,338	1,912	7,932	13,976
Italy	653	978	144	281	525	909	867	1,223	384	669	577	764	3,150	4,842
UK	1,139	1,997	937	1,445	1,042	2,116	898	1,243	717	942	1,482	2,228	6,215	9,971
W. Germany	1,666	2,641	2,189	3,347	547	883	2,122	3,013	3,024	3,937	3,590	5,355	13,138	19,176
Rest	980	1,417	1,570	2,399	823	1,189	2,660	4,044	1,983	2,397	2,350	3,019	10,366	15,637
Total	5,595	9,021	5,444	8,489	4,742	9,304	8,595	13,628	7,106	8,980	9,337	13,278	40,801	50,068

Source: MacIntosh Consultants Co. Ltd.
Note: 1977 figures are actuals, 1980 are projections based on 1979 figures.

Table 7b: 1980 European production (estimates) by equipment segment (US $m.)

Products	France	Italy	UK	W. Germany	ROWE	Totals
COMPONENTS						
Colour TV tubes	203	142	139	557	234	1,275
Valves and tubes total	307	142	321	721	551	2,042
ICs	111	77	153	306	72	719
Semiconductors total	500	141	357	635	312	1,945
Passive components	790	185	859	1,842	1,010	4,686
Audio components	315	296	685	1,825	1,108	4,229
ELECTRONIC DATA PROCESSING						
Electronic calculators	43	72	4	80	56	255
Automatic typewriters	10	42	-	40	62	154
Electronic accounting machines	39	71	37	70	12	229
CONSUMER						
Televisions	810	546	823	2,502	1,314	5,995
Radios	150	84	26	1,057	388	1,705
Other audio consumer equipment	57	39	93	378	695	1,262
CONTROL AND INSTRUMENTATION						
Electronic control and instrumentation	775	208	1,155	2,781	1,723	6,642
X-ray and other medical equip.	242	73	290	566	676	1,847
COMMUNICATIONS						
Radar and navigational aides	2,185	392	1,133	193	1,189	9,034
Radio comm. and public broadcasting	1,751	517	983	690		
TELECOMMUNICATIONS						
Exchanges	2,467	890	521	3,013	4,044	13,628
Other telecommunications equipment	1,638	333	722			
TOTALS	12,393	4,250	8,301	17,256	13,446	55,647

Source: *Mackintosh Yearbook of Western European Electronics Data*, Mackintosh Publications, 1980.

with virtually no production of calculators and automatic typewriters. Taken in its entirety, the UK electronics sector has a size and structure roughly appropriate to the economy of which it is a part, but it is sufficiently deficient in certain particulars for one to be able to anticipate a future in which the UK (like Italy and possibly France, but unlike Germany) is not represented across-the-board in industrial electronics.

Ownership and control

The ownership structure of the UK electrical goods industry is characterised by relatively large firm and plant size and by relatively high concentration (Tables 8a and 8b). This is particularly true of electronic computers, telegraph and telephone equipment, and consumer electronics but also extends to some more conventional electrical engineering, particularly wires and cables and electrical appliances. As a table of leading European companies (Table 9) shows, however, no UK company is in the top five. Even the largest - GEC, Plessey, ICL - are of modest size by comparison with Philips and Siemens, let alone the US multinationals. US companies are well represented in the UK, as in Europe generally (there were 13 US companies in the top European 50), and Japanese firms have also rapidly increased their stake either as direct investors or in joint ventures with European companies (eg Sharp with Thorn-EMI, GEC with Hitachi).

One of the distinctive features of the largest UK companies, which does much to explain the direction of UK trade policy, is their negligible involvement through direct investment, or subcontracting, in the emerging electronics export industries of the NICs. Thorn-EMI, for example, the leading consumer electronics firm,

Table 8a: Industrial concentration

	Sales share of five leading companies[a]		
	1963	1968	1975
All manufactures	na	na	na
Electrical engineering	na	na	na
Electrical machinery	53.6	71.2	68.8
Insulated wires and cables	91.7	89.3	90.4
Telegraph and telephone apparatus and equipment	95.1	98.2	96.9
Radio and electronic components	55.8	58.9	58.2
Broadcast receiving equipment	71.8	84.6	81.0
Electronic computers	73.3	86.2	86.4
Radio/radar and electronic capital goods	62.2	74.2	80.5
Electrical appliances for domestic use	71.0	78.5	85.03
Others	64.6	73.0	78.2

Source: *Business Monitor* PA 10002, Table 6 and Census of Production, 1968.
Note: [a] Percentage of total industry sales accounted for by the five leading companies. These figures are derived as an average of a more detailed four digit MLH breakdown.

Table 8b: Changes in the size of enterprise in electrical engineering industries

	No. of enterprises		No. employed (000s)- % share of total employment in brackets			
	1963	1976	1963		1976	
Numbers employed in electrical engineering						
1-99	1890	3945	36.6	(4.8)	58.0	(7.6)
100-199	148	172	20.9	(2.7)	23.9	(3.1)
200-499	132	155	41.9	(5.5)	48.2	(6.3)
500-999	70	63	58.8	(6.4)	44.6	(5.8)
1000+	84	63	617.5	(80.6)	531.6	(69.4)
Total	-	4401	765.7	(100.0)	706.3	(100.0)
Electrical machinery						
1-99	453	964	9.7	(4.4)	15.0	(10.5)
100-199	30	42	4.8	(2.2)	5.9	(4.1)
200-499	47	37	15.1	(6.9)	11.1	(7.8)
500-999	23	27	16.9	(7.7)	18.8	(13.1)
1000+	23	15	172.8	(78.5)	92.4	(64.5)
Total	618	1085	220.1	(100.0)	143.2	(100.0)
Insulated wires & cables						
1-99	31	47	1.0	(1.9)	1.0	(2.4)
100-199	11	9	1.6	(3.0)	1.3	(3.1)
200-499	8	12	2.7	(5.1)	39.6	(94.5)
500-999	14		47.6	(90.0)		
1000+						
Total	68	68	52.9	(100.0)	41.9	(100.0)
Telegraph and telephone apparatus and equipment						
1-99	21	88	0.5	(0.6)	1.7	(2.1)
100-199	9	14	1.0	(1.2)	2.1	(2.6)
200-499	5	8	1.5	(1.7)	2.7	(3.3)
500-999	10	8	84.0	(96.4)		(92.2)
1000+						
Total	48	118	87.1	(100.0)	81.5	(100.0)
Radio and electronic components						
1-99	245	832	4.7	(5.6)	12.5	(11.4)
100-199	29	41	4.1	(4.8)	5.9	(5.4)
200-499	19	54	6.1	(7.2)	17.0	(15.5)
500-999	12	16	8.8	(10.4)	10.6	(9.7)
1000+	17	11	61.0	(72.0)	63.7	(58.1)
Total	345	954	84.7	(100.0)	109.7	(100.0)
No. employed in broadcast receiving and sound reproducing equipment						
1-99	69	289	1.8	(3.4)	3.6	(8.0)
100-199	10	21	1.2	(2.2)	5.1	(11.3)
200-499	23		50.6	(94.4)		
500-999		16			36.5	(80.9)
1000+						
Total	115	326	453.6	(100.0)		(100.0)

/. . . continued over

Table 8b: continued

Electronic computers						
1-99	21	109	0.3	(2.9)	2.1	(7.9)
100-199	4	10	0.8	(7.7)	1.3	(4.9)
200-499		13			23.3	(87.3)
500-999	-		-			
1000+	4		9.2	(88.5)		
Total	32	132	10.4	(100.0)	26.7	(100.0)
Radio/radar and electronic capital goods						
1-99	169	689	3.5	(4.6)	8.3	(8.6)
100-199	9	33	1.2	(1.6)	4.3	(4.5)
200-499	9	14	2.7	(3.6)	4.4	(4.6)
500-999	4	21	2.7	(3.6)	79.3	(82.4)
1000+	12		65.2	(86.6)		
Total	223	757	75.3	(100.0)	96.3	(100.0)
Electrical appliances for domestic use						
1-99	142	216	2.9	(4.1)	4.0	(6.8)
100-199	21	14	2.8	(3.9)	2.2	(3.7)
200-499	15	19	4.3	(6.0)	2.8	(4.7)
500-999	17	9	11.4	(15.8)	6.6	(11.2)
1000+	13	11	50.3	(69.7)	43.4	(73.4)
Total	224	259	72.2	(100.0)	59.1	(100.0)
Miscellaneous electronic products 369						
1-99	856	810	13.6	(12.4)	11.4	(11.1)
100-199	50	33	6.5	(5.9)	91.4	(88.9)
200-499	35	59	14.7	(13.4)		
500-999	23		6.5	(5.9)		
1000+	32		68.0	(62.2)		
Total	914	902	109.3	(100.0)	102.8	(100.0)

Source: Summary tables of Census of Production 1968 and Business Monitor.

has a world-wide network of operations but these are almost entirely rentals operations and where there are arrangements for the supply of knockdown chassis or technology - Scandinavia, Hong Kong, China, Italy - these are not intended to compete with UK subsidiaries. The company is far from ethnocentric - it has shown great interest in link-ups with or buying into US, Japanese and other developed country companies - but the use of low labour cost assembly plants does not appear to have been part of its global strategy as it is of many of its overseas competitors. The other major consumer goods' manufacturer is Rank. Rank has a minority holding in Indian radio manufacturers Murphy (India) and Bush (India) but this has been largely to secure an interest in a traditional market threatened by import substitution. Similarly, the largest UK semiconductor manufacturer, Plessey, has not followed other major producers to the NICs. Its largest operations in the Far East are in Australia and, though there are subsidiaries in Hong Kong, Singapore and Brazil, as in most other countries of any significance, the only attempt to use an overseas subsidiary for 'offshore' purposes seems to have been a flop (an unprofitable semiconductor plant in Malaysia). Perhaps the most ambitious link-up in the Third World has been Ferranti's association with 'Cobra', the Brazilian company which manufactures defence systems for use in aircraft.

The interests of UK 'multinational' companies in ldcs are therefore varied but are, in general, in support of UK exports rather than as part of truly multinational global sourcing operations. By contrast, foreign companies based in the UK such as Philips, almost certainly do operate globally in their procurement of components and subassemblies and this goes some way to explaining the increasing evidence of inter-company trading in UK imports.[35] But evidence of

Table 9: Leading European and UK companies ($m)

Company	Control of origin	Ranking in European Top 50	Total electronic sales	Total sales	Fiscal year
NV Philips	Neth.	1	9,200	15,119	31.12.78
IBM (European operations)	US	2	7,390	21,076	31.12.78
ITT (European operations)	US	3	6,890	15,261	31.12.78
Siemens AG	Germany	4	6,490	1,444	30.9.78
Thomson Brandt	France	5	3,844	5,066	31.12.78
AEG Telefunken	Germany	6	3,336	7,015	31.12.78
GEC	UK	7	2,038	4,808	31.12.78
Plessey	UK	12	1,067	1,247	31.3.79
ICL	UK	14	979	980	30.9.79
Thorn	UK	31	435	2,323	31.3.79
EMI	UK	33	425	1,672	30.6.79
Rank	UK	35	404	933	31.10.75
Racal	UK	36	296	369	31.3.79
Decca	UK	42	262	351	31.3.79
BSR Ltd	UK	47	209	307	1.6.79

Source: *Electronic Business*, based on Mackintosh International estimates.
Notes: [a] Figures are not strictly comparable because of different accounting years (and therefore different dollar exchange rates).
[b] For European companies, the sales of electronics are for world-wide turnover. For US companies, only European turnover is included.
[c] Total turnover is net of intra-group trading.

foreign investment by no means exhausts the possibilities for involvement by UK firms in the developing country export industries. There is a widespread practice of UK firms sending out specifications and designs to South East Asian producers and reimporting the goods under their own labels. Thus Rank imports clock radios from Hong Kong under the 'Bush' label. In this way British firms do derive some benefit - in terms of profits at least - from the international division of production.

Industry characteristics

The theory of the product cycle would lead us to suppose that developed industrial countries have a comparative advantage in products which use R & D relatively intensively (on the assumption that this is what triggers off innovation) or which, in their 'growth' phase, are relatively capital-intensive or call for a wide range of complex technical skills. The analysis of these product characteristics at a country level is bound to be an unsatisfactory business since industrial census categories are highly aggregated. Some key pieces of information, such as capital stock data, are not available in the UK. The analysis is, moreover, rendered difficult by the spread of ownership beyond neat statistical boundaries. Thus GEC's research budget could be allocated to purposes such as the development of computers, radios and capital goods, components and electrical machinery in a way that is almost certainly impossible to unscramble satisfactorily.

Making what we can of the statistics, however, the picture which emerges with greatest clarity is that electrical engineering is very labour-intensive in relation to the manufacturing average (Table 10). Net investment per head (a rough proxy for capital stock per head) in recent years has been only two-thirds of the manufacturing average,

Table 10: Structural characteristics of UK electrical engineering industry

	1970-77 I/L[a]	1973 VA/L[b]	1977 VA/L	1970 L/O[c]	1977 L/O	1970 AVER.-WAGE[d]	1977 AVER.-WAGE[d]	1970 NON-MANUAL[e]	1977 NON-MANUAL[e]	1977 % WOMEN & SEMI-SKILLED	1976 % UN-SKILLED	1976 % REGION[f]
All manufactures	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Electrical engineering	65.6	89.0	79.0	126.7	130.4	95.9	98.2	124.2	124.5	126.3	132.1	104.8
Electrical machinery	48.4	84.1	83.5	133.4	132.9	100.6	103.0	131.3	133.9	83.8	103.6	85.7
Insulated wires & cables	123.5	99.1	89.9	64.7	84.4	113.4	109.5	120.3	110.8	95.0	103.6	47.6
Telegraph & telephone apparatus & equipment	68.0	79.3	70.6	186.3	205.1	89.6	99.9	109.1	123.7	133.2	132.2	90.5
Radio & electronic components	77.8	82.9	70.2	122.8	169.6	84.4	85.4	112.0	103.0	172.9	146.4	95.2
Broadcast receiving equipment	83.9	90.3	63.6	85.1	109.4	82.2	87.5	127.0	106.3	175.3	153.6	na
Electronic computers	100.0	192.7	158.6	79.7	47.6	114.5	142.7	193.3	230.5	92.2	57.2	na
Radio/radar & electronic capital goods	95.7	90.6	86.7	134.1	142.6	108.8	109.0	194.6	180.3	95.3	85.7	47.6
Electrical appliances for domestic use	64.8	87.9	56.8	122.8	129.7	98.5	93.2	113.1	99.4	116.5	153.6	161.9
Others	58.9	82.0	73.3	146.2	159.2	98.8	83.8	87.0	80.0	145.7	164.3	66.7

Source: *Business Monitor* PA 1000, Table 1, 1977, 1976 and 1975. *Department of Employment Gazette*, 1977.

Notes: [a]I/L = Net investment per head which is taken as a rough proxy for physical capital intensity since no capital stock measures are available. Total net investment 1970-77/Total employment 1977.
[b]VA/L = Gross value added per man also sometimes used as a measure of (relative) capital intensity, the 'Lary Measure'.
[c]L/O = A crude measure of labour intensity derived as the inverse of gross output per man (O/L) which measures labour productivity.
d = Total wage and salaries divided by employees.
e = Percentage of the workforce which are non-manual; female (next column); unskilled (penultimate column).
f = Percentage of the workforce located in 'depressed' regions of the country (from Census of Production, 1976).
g = All statistics are presented as 'index' numbers where the average value for manufacturing as a while is presented as the unit of measurement.
h = This category includes electrical equipment for motor vehicles, cycles and aircraft, primary and secondary batteries, lamps and light fittings.

with only one branch, computers, in excess of the industrial average. Output per man for the electrical engineering sector is 77% of the manufactured average and some sub-sectors, telecommunications, miscellaneous goods (ie light fittings, lamps), are much less than that. Only computers, and wires and cables, have a relatively low labour intensity on this measure. The labour intensity of some of these sub-sectors is high even by comparison with the textile industry (but not clothing) though this is also true of the UK's mechanical engineering and scientific instruments industries.

What differentiates those relatively labour-intensive industries in which the UK has a comparative trading advantage from textiles and other 'traditional' labour-intensive industries is the skill - or 'human capital' - of the labour force. The skill level of the electrical engineering workforce, however, is relatively low except for computers and capital goods. These two items aside, the share of unskilled and semi-skilled workers is well above the average for manufacturing, and is particularly high for broadcasting equipment (radios and TVs), components, telecommunications equipment, electrical appliances, and miscellaneous goods. The same categories have relatively low wages and a relatively high share of women in the labour force (all these factors being inter-related). The main item of conventional electrical engineering (machinery) is much closer to the characteristic skill pattern of the engineering industry as a whole. 'Skill' is, however, only one component of the 'human capital' of an industry. The R & D expenditure of the sector, at 5% of sales, is substantially in excess of that for the economy as a whole (1.5%) (Tables 11a and 11b). But most of this is spent on computers and electronics capital goods and the R & D devoted to domestic appliances is lower than the manufactured average (it is not possible separately to identify components or consumer electronics).

Table 11a: Research and development spending (% of sales)

	1972		1975	
	Total	Company funded	Total	Company funded
Total manufacturing	1.53	0.99	1.42	0.93
Electrical engineering				
Total	5.07	3.02	4.82	2.70
Electrical machinery	3.16	2.48	2.34	1.84
Wires and cables	1.01	1.01	1.41	1.34
Components/tele-communications equipment	8.00	4.13	7.26	2.86
Computers	10.32	7.06	9.06	7.67
Domestic appliances	0.75	0.75	1.10	1.10
Miscellaneous electrical	1.42	1.15	2.63	2.22

Table 11b: Operating ratios: 1975 - R & D expenditure as a percentage of sales (brackets - private)

	No. of companies	Lower quartile	Median	Upper quartile
Electronics	53	0.8	2.9 (2.6)	7.6 (4.75)
Electric plant & machinery	23	0.6	1.2	1.9
Wires & cables	25	0.5	0.7	1.6

Source: *Business Monitor* MO14.

It would be rash to draw strong conclusions from such patchy data, but one could hypothesise that the UK could expect to face competition from 'low cost' countries making 'mature' products in substantial areas of electrical engineering, where manufacture can be characterised as relatively (unskilled) labour-intensive, components (at least some of them), broadcasting and TV equipment, some 'miscellaneous' products (light fittings), telecommunications (to the extent that there is no protected Post Office monopoly), and some domestic appliances (where the products are not too bulky). If fully realised this would represent a substantial, and widely distributed, addition to pressures for adjustment.

B. TRADE PERFORMANCE

Evaluating the trade performance of UK electrical engineering in relation to developing countries requires, if it is to be meaningful, a basis of comparison with other UK industries and also of comparable experiences in other industrialised countries. Unfortunately the data do not permit such a multidimensional comparison to be made. It is possible to look at import penetration data and export sales ratios across UK industries for all trade and trade with ldcs. However, it is not yet possible to compare import penetration between countries, though some fragmentary, aggregated, data are available for Europe. Trade data do permit a comparison between countries of the share of ldcs in imports (not consumption), which is, of course, a somewhat different matter.

Table 12 summarises an international comparison of imports of the main categories of electrical goods by origin and destination. What is significant is that the UK share of imports from developing countries, and the main NIC suppliers, in overall national imports is significantly

smaller than for other OECD countries on average, for each of the main product categories illustrated. This is a characteristic shared by the EEC as a whole (but less so for Germany and Holland). The share of ldcs in imports by the United States, particularly, is much higher (and the same is also true of Japan although it is not shown). On the other hand, the European economies are, in general, more open than either of these two countries and so ldcs can achieve a higher penetration even with a lower share of total imports. How do these two influences balance out? One simple test is to measure ldc imports as a proportion of the importing country's GNP. In the case of the UK, it has a GDP, very roughly, of 5% of the OECD total. Its share of overall OECD imports is, however, somewhat less and its share of OECD imports from ldcs very substantially less. The level of market penetration by ldcs is very much less than in the USA, higher than in Japan, and roughly on a par with the rest of the EEC (where Germany is somewhat more 'open' to ldcs and France and Italy rather less). One likely explanation for these differences is an association between trade flows and the behaviour of multinational companies. Where electrical goods production has not been 'internationalised' by domestically based mncs - as with UK (and also with French and Italian) firms - the involvement of ldcs as sources of imports is correspondingly low. By contrast with the USA, Germany and Holland, relative 'openness' may be a function of the 'offshore' involvement in ldcs by multinationals from those countries. Japan is a rather different case. Japanese mncs appear to use ldcs primarily as a jumping-off point for exporting goods made of Japanese components to other developed countries.

A somewhat more precise picture of comparative trade performance but with less direct bearing on ldcs is given by Table 13. In all branches of European electronics (where governments are the main consumers) the degree of

Table 12: OECD imports[a] by country and product, 1977 ($ million)

Selected products from SITC 72	USA			FRANCE		
	Total	ldcs	% of total imps.	Total	ldcs	% of total imps.
Electric power machinery & switchgear	973.8	324.7	33.3	650.7	13.7	2.1
Apparatus for electrical circuits	517.0	188.7	36.5	399.4	8.3	2.1
Equipment for distributing electricity	216.0	126.8	58.7	132.0	6.0	4.5
Telecommunications apparatus	3748.8	1405.3	37.5	778.6	72.6	9.3
Radio broadcast receivers	1090.5	510.6	46.8	237.5	61.3	25.8
Telecom. equip. nes	1793.3	580.6	32.4	364.9	10.2	2.8
Domestic electrical equipment	542.6	101.8	18.8	462.7	8.2	1.8
Other electrical machinery & equipment	2798.4	1645.0	58.8	1558.5	45.3	1.9
Thermionic valves, tubes & transistors	1511.9	1244.0	52.3	441.8	24.0	5.4
Electrical measuring & controlling instruments	297.3	35.7	12.0	421.0	1.7	0.4
Totals	10,970.2	4682.7	42.7	4044.5	251.3	6.2

Source: OECD Trade Statistics Series C Jan-Dec 1977.

Note: [a] Ldcs are here defined to cover all imports from non-OECD countries excluding Comecon.

GERMANY			ITALY			UK			SWEDEN		
Total	ldcs	% of total imps.	Total	ldcs	% of total imps.	Total	ldcs	% of total imps.	Total	ldcs	% of total imps.
1055.3	63.4	6.0	488.9	20.7	4.2	543.5	25.2	4.6	399.0	3.2	0.8
616.9	30.0	4.9	282.9	4.8	1.7	349.9	15.3	4.4	235.6	2.3	0.9
160.3	6.4	4.0	40.1	2.6	6.5	66.9	2.3	3.4	60.2	0.6	1.0
1297.2	181.7	14.0	579.6	69.5	13.7	780.2	110.0	14.7	362.2	20.3	5.6
431.5	127.8	29.6	105.1	51.5	49.0	297.2	60.8	20.5	104.8	14.3	13.6
610.9	27.2	4.5	328.3	26.6	8.1	289.9	31.1	10.7	161.8	4.1	2.5
534.1	31.8	5.9	118.3	5.0	4.2	329.1	4.5	1.4	178.8	0.6	0.3
2204.4	155.7	7.1	989.0	43.2	4.4	1337.3	124.1	9.3	569.8	8.3	1.4
899.1	104.2	11.6	347.2	27.9	8.0	464.3	66.3	14.3	133.9	5.0	3.7
432.1	12.6	2.9	221.7	1.8	0.8	356.7	30.4	8.5	116.2	0.9	0.8
6257.8	740.8	11.8	3500.2	263.6	7.5	3581.4	470.0	13.1	2322.3	59.6	2.6

Table 13: Trade performance of main European countries (in 1977, $ million values)

	France	Italy	Germany	UK	All Europe
Computers					
B[a]	+3	(84)	13	(213)	(1134)
IP[b]	81.1	44.6	45.2	60.0	64.1
ES[c]	81.2	37.5	45.6	52.5	56.4
Control & instrumentation					
B	(134)	(156)	415	49.0	116
IP	90.7	102.6	33.1	60.0	63.2
ES	88.6	105.5	45.8	62.1	64.0
Communications					
B	632	81	47	381	1044
IP	8.6	16.9	37.2	47.2	29.5
ES	40.8	29.7	42.6	66.5	45.0
Telecommunications					
B	117	59	445	125	1384
IP	4.6	8.0	6.1	10.0	12.5
ES	10.0	614.3	25.8	22.5	26.5
Consumer goods					
B	(584)	(156)	222	(360)	(1500)
IP	47.9	56.9	78.7	57.4	53.0
ES	17.3	39.3	34.4	36	43.2
Components					
B	(179)	(136)	87	(228)	(1452)
IP	157	92.1	54.3	45.6	68.8
ES	51.2	90.2	55.4	37.2	64.0
Total electronics industry					
B	211	(392)	1229	(246)	(1502)
IP	44.2	49.0	36.5	48.4	51.1
ES	20.9	42.7	42.4	46.4	49.3

Source: Mackintosh European Yearbook, 1978.

Notes: [a] Balance of trade in US $ millions.
[b] Import penetration given as total imports as a percentage of domestic production.
[c] Export sales ratio given as total exports as a percentage of domestic production.

international specialisation is extremely high, with import penetration rates averaging well over 50% and with export sales ratios also very high. The position of the UK does not stand out as exceptional either in terms of the degree of international integration in electronics goods or in relative uncompetitiveness (though we are dealing with only one year, and in that year British trade performance in electronics could be seen to be deficient in relation to Germany and, to a lesser extent, France, though not to the rest of Europe). The UK's weakest performance is in consumer electronics with an import penetration ratio of almost 60% (with Italy about the same, France almost 50% and Germany 30%) and an export sales ratio of 35% (though the French is only 17%).

Reverting to the UK alone, Tables 14 and 15 show the broad trends in import penetration and export performance for the electrical goods sector as a whole as well as the sectoral trends in 'Revealed Comparative Advantage'. As with UK manufacturing generally, import penetration has risen steadily over the last decade (more or less matched by a rise in the ratio of exports to sales). Some relative deterioration in competitiveness has occurred, however, in two main sub-sectors - consumer electronics and electrical appliances (though there has also been a sharp rise in import penetration in wires and cables, telecommunciations, and electrical machinery, albeit from a lower base). Only in consumer electronics are developing country competitors of any note. But even here the tables show ldcs to have relatively minor influence. They have taken an additional 5% of the UK broadcast receiving equipment market in value terms over the years 1970-78, while overall import penetration increased by 30% in this time. The influence of Japan was substantially greater. Developing countries have, however, played virtually no role in the rapid increase in import penetration of electrical appliances, which originate mainly in Southern Europe and Japan.

Table 14: Trade performance of UK electrical engineering industry

	Import penetration (world)[a]					Import pen. (ldcs)	
	1968	1970	1976	1977	1978	1970	1978
All manufactures	17	17	23	24	25	na	na
Electrical engineering	14	17	32	35	37	na	na
Electrical machinery 361	8	10	20	21	28	0.12	1.2
Insulated wires & cables 362	2	2	6	6	7	0.04	0.12
Telegraph and telephone apparatus and equipment 363	4	5	14	10	10	0.09	0.22
Radio and electronic components 364	30	29	50	52	54	0.95	4.7
Broadcast receiving equipment 365	13	12	37	45	52	1.4	6.6*
Electronic computers 366	46	64	78	82	87	0.56	1.7
Radio/radar and electronic capital goods 367	15	16	23	23	24	1.0	3.4
Electrical appliances for domestic use 368	11	12	27	30	30	0.05	0.3
Others 369	9	9	19	24	22	0.75	1.0

Source: *Business Monitor* MIO and *Business Monitor* PQ 1002 (various).

Notes: [a] Import penetration is given by imports from area in question/home demand x $\frac{100}{1}$, where home demand = manuf. sales + imports - exports.

[b] Export sales ratio = exports to area in question/domestic manufacturers sales.

* Based on sales figures for 1977.

Import pen. Japan			[b] Export/sales (world)				Export/sales (ldcs)		Export/sales Japan	
1970	1978	1968	1970	1976	1977	1978	1970	1978	1970	1978
na	na	17	18	23	25	25	na	na	na	na.
na	na	20	21	37	40	40	na	na	na	na
0.16	1.3	18	22	41	43	50	6.7	28.6	0.09	0.76
0.04	0.25	18	14	27	29	25	8.7	18.1	0.13	0.06
0.13	0.15	17	15	22	24	17	9.1	10.0	0.02	0.02
0.60	0.64	30	28	49	50	52	4.5	11.5	0.37	0.98
2.7	18.6*	9	7	25	29	24	0.95	4.0*	0.08	0.26*
0.23	0.51	38	48	72	77	84	1.8	5.4	1.0	0.8
0.34	0.92	32	31	41	44	38	10.4	17.1	0.32	1.2
0.09	1.5	15	19	23	26	24	3.3	5.8	0.17	0.06
0.26	1.4	15	18	26	20	29	5.2	12.0	0.14	0.08

Table 15: UK electrical engineering: Revealed Comparative Advantage with selected trading partners[a]

	RCA with world		RCA with Japan		RCA with ldcs	
	1970	1978	1970	1978	1970	1978
All manufactures	na	na	na	na	na	na
Electrical engineering	na	na	na	na	na	na
Electrical machinery 361[b]	0.42	0.44	-0.45	-0.08	0.97	0.94
Insulated wires & cables 362	0.76	0.62	0.60	-0.53	0.99	0.99
Telegraph & telephone apparatus & equipment 363	0.51	0.29	-0.76	-0.77	0.98	0.96
Radio and electronic components 364	-0.03	-0.03	0.52	-0.74	0.65	0.43
Broadcast receiving equipment 365	-0.28	-0.37	-0.94	-0.98	-0.22	-0.37
Electronic computers 366	-0.31	0.14	0.58	0.10	0.42	0.42
Radio/radar and electronic capital goods 367	0.39	0.31	0.05	0.23	0.85	0.72
Electrical appliances for domestic use 368	0.25	-0.15	0.33	-0.92	0.97	0.98
Others 369	0.36	0.16	-0.25	-0.76	0.77	0.78

Notes: [a] Given by the formula $\frac{X - M}{X + M}$ where X = exports, M = imports.

[b] MLH categories.

Source: This table was made up from calculations undertaken by V. Cable and I. Rebelo for the World Bank. See 'Britain's Pattern of Specialisation in Manufactured Goods with Developing Countries and Trade Protection', World Bank Staff Working Paper No. 425, October 1980.

The only other sector in which ldcs have achieved a market share approaching 5% is electronics components but, there, the position of the UK industry has been remarkably stable, with no significant deterioration of competitiveness overall, and with a substantial growth of exports to ldcs including those countries which are exporters, to Britain, of final products. There is the beginning of developing country competition in electronics capital goods (such as navigation equipment and medical equipment), in small bits of computing equipment and in miscellaneous products, notably light fittings. But none of this is at all significant as yet and is far outweighed by exports.

This assessment is borne out by examining sectoral changes in Revealed Comparative Advantage (RCA) over the same time period (see Table 15). Broadcast receiving equipment is the main sector where a deterioration in UK international performance is observable (in these terms) and this is mainly due to a declining RCA value vis-à-vis the ldcs. With Japan the RCA value remained close to minus one (ie the minimum measure possible). Negative RCA values also emerged in components and domestic appliances and this was more due to the influence of improved trading performance by Japan.

This very mixed picture, of deteriorating competitiveness in some branches but not others, is reflected in the attitudes of representatives of the different branches, expressing their views through the sector working parties of NEDO or through the trades union movement.[36] In the 'traditional' electrical machinery area no competitive threat is yet perceived from developing countries (rather, they are important markets). There are complaints about 'cheap' (allegedly 'dumped') imports from Eastern Europe but, especially at the heavier end of the industry, there is little import competition of any kind (partly because nationalised industries patronise UK firms for power stations

and the like). There are commercial policy disputes in the fields of electronic computers, capital goods, and telecommunications equipment about public procurement but never, yet, concerning ldcs. There are growing worries in the field of 'brown goods' (domestic appliances), so far about trade with Eastern Europe (alleged dumping), Italy and Japan.[37] This branch may well become a sphere of trade competition with some NICs though this possibility will, in turn, be influenced by microprocessor application over the next few years. The TUC has also asked for investigation of rising import penetration of lamps and highlights, and wire and cables - though in neither case is there an active lobby to resist competition. The main problem area is consumer electronics and we shall therefore deal with this in detail.

Before dealing with consumer goods, however, it would be appropriate to refer briefly to electronic components. Although difficult to analyse since it is so complex, the components branch is the core of the electronics industry. It is in the field of semiconductors that the main high technology competition between countries is taking place. Actual and potential ldc competition is not, directly, a major issue in the components industry (though worries have been expressed about some products such as printed circuit boards).[38] There are, however, more subtle ways in which such competition is important. The complex inter-relationship between consumer goods and their component inputs has formed an important part of the arguments about protecting the UK industry from Far Eastern competition. This particular issue will be pursued in more detail below. It suffices for the moment to mention that the UK component industry has been particularly affected by the lack of 'internationalisation' of UK electronics firms for several reasons. First, components made in South East Asian NICs, usually by Japanese and US companies, compete directly with UK components. There are fears that foreign, and particularly

Japanese, companies in the UK will resort to such global 'sourcing' at the expense of the component suppliers. Second, imported components compete indirectly to the extent that they are incorporated in imported final products. Finally, UK firms have had a negligible share of OECD exports of components to the rapidly growing Asian economies. These markets are monopolised by 'tied trade' generated by Japanese and US (and some European) companies. Japan alone exports far more by value in semiconductor components to the rest of the Far East than it imports in any form of electrical goods. One of the objectives of the major effort being put into the development of more advanced integrated circuits in the UK, (assuming that they can eventually be mass-produced in Britain by capital-intensive methods) is to recover some of the lost ground gained earlier by Japanese and US multinationals through their division of production with ldcs.

Consumer Electronics

A. THE INDUSTRY

The consumer electrical goods industry, as normally defined, includes the manufacture of colour and mono TVs, and a miscellany of 'audio' products: radios, record players, tape recorders, tuners, amplifiers and other hi-fi equipment, all of these things produced separately or in combination. Strictly speaking, consumer electronics could include other forms of consumer goods such as electronic games, watches and clocks, and hand-held calculators. These are, however, not separately identified statistically, are scarcely produced in the UK, and are normally produced as offshoots of other industries; they are ignored, therefore, for our purposes.

Of the total sales of the industry in 1979 (£530m.), two-thirds was accounted for by colour TVs, 7.5% by mono TVs and the rest by audio products. There were roughly 40,000 workers directly employed in making TV tubes and audio components. The industry is of modest importance in employment terms, providing less than 10% of all employment in electrical engineering as a whole. It is also built around one product: colour TVs. There are ten colour TV manufacturers of any consequence, of which five are wholly foreign-owned and two partially so (at least until Rank's recent withdrawal from its partnership with Toshiba). Their combined (1979) production distributed roughly as shown in Table 16. Of the total of approximately 1.8m. sets the Japanese companies represent

the most rapidly growing element in production. All have plans to expand. Although these plans have been set back by the current recession all five Japanese companies had short-term expansion objectives to raise their combined output to approximately 950,000 in 1981.

Table 16: Approximate colour TV production, by sets, 1979

BRITISH		OTHER FOREIGN		JAPANESE (including partnerships)	
Thorn/EMI	450,000	Pye/Philips	400,000	Rank/Toshiba (now Toshiba)	150,000
Rediffusion	100,000	ITT	150,000	Hitachi/GEC	150,000
Racal/Decca	100,000			Sony	200,000
				Mitsubishi	75,000
				Matsuchita (National Panasonic)	- plants just commencing production
	650,000		550,000		575,000

Black and white TVs are still produced (by Thorn-EMI and GEC - and Fidelity has recently started production). In the much depleted audio field, music centres and hi-fi equipment are still produced by Rank, Decca, BSR, Fidelity and GEC among UK companies and by Philips and Grundig (25% owned by Philips) among European firms. There is considerable product specialisation in many of the smaller items. Car radio production, for example, is largely carried out by two firms: Radiomobile and Motorola.

Table 17: The UK consumer electronics industry

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Output (sales), £m.	199	248	348	433	424	414	427	466	545	530
Exports, £m.	14	14	18	23	44	78	95	112	123	126
Imports, £m.	35	58	120	242	203	185	227	327	365	512
UK market, £m.	220	292	450	652	583	521	559	681	787	916
Import penetration, %	16	20	27	37	35	35	41	48	46	56
Exports, as % of output	7	6	5	5	10	19	22	24	23	24
Balance of trade, £m.	-21	44	-102	-219	-159	-107	-132	-215	-242	-386
UK output (constant prices), £m.	199	241	329	401	367	312	295	288	361	na
Employment[a] GB, '000s	44	58	61	69	64	55	52	52	50	45

Source: *Business Monitor, Overseas Trade Statistics, Department of Employment Gazette* - published in SWP 1979.

Note: [a] Employment statistics are only available for the whole of MLH 365, which includes the manufacture of gramophone records, pre-recorded tapes, etc. It has been estimated that in 1977, employees engaged in the manufacture of consumer electronics accounted for 44,000 out of a MLH total of 52,000.

B. A DECLINE IN COMPETITIVENESS

The story of the declining competitiveness of British consumer electronics is told in Tables 17 and 18. Output in real terms and employment have both fallen sharply from the peak of 1973. Import penetration has increased from 16% to 56% over the decade since 1970 with a rise in exports in relation to output which falls well short of compensating. Consequently the trade balance has deteriorated (interrupted by a short-lived recovery in 1974 and 1975). Most of the deterioration has occurred in radios and miscellaneous audio products which are now either not produced at all, or produced in small quantities. A considerable loss of competitiveness has also occurred in monochrome TVs and since 1975 imports of colour TVs have also exceeded exports, particularly of small portable sets.

Table 18: Import penetration (%) and in brackets trade balance (£m. current prices)

	1975	1977	1979
CTV	15 (0)	17 (-4)	22 (-29)
MTV	39 (-11)	42 (-16)	47 (-28)
Audio and others	67 (-95)	83 (-194)	85 (-329)

Source: NEDO.

Table 19: UK imports of consumer electronics by product and country, 1979

Products	Total imports		Far East		Singapore	
	Volume 000's		Volume 000's	%[d]	Volume 000's	%
Colour TV receivers	(366)*	514.0	268.2	52.2	60.8	11.8
Small screen mono TV receivers	(581.7)	708.7	621.7	87.7	182.8	25.8
Radiograms & record players	(45.3)	18.5	3.5	19.1	2.8	15.3
Music centres	na	642.7	519.6	80.8	10.0	1.6
Hi-fi equipment[a]	(467.2)**	789.8	671.3	85.0	3.7	0.5
Tape-recorders[b]	(2499.3)	3878.3	3549.4	91.5	261.9	6.8
Car radios/tape-recorders	(1851.8)	3130.6	2256.4	72.1	114.5	3.7
Radios[c]	(5271.4)	7992.2	7745.5	96.9	713.8	8.9
Video recorders	(95.6)	178.9	151.9	84.9	-	-
Games	na	1401.3	1298.3	92.6	20.6	1.5

Source: Supplied by BREMA.

Notes: * Figures in brackets are for 1978.
** This figure excludes the 1977 imports for tuners which was unavailable.
a Tuners, amplifiers, tape decks, turntables and combinations thereof.
b Domestic (audio) recorders, and cassette recorders.
c Clock radios, mains radio and portable radio receivers.
d Percentage of total imports.
e NICs here defined as four countries shown.

Taiwan		Hong Kong		South Korea		Japan		Total NICs[e]	
Volume 000's	%	Volume 000's	%	Volume 000's	%	Volume 000's	%	Volume 000's	%
0.7	0.1	1.7	0.3	-	-	205.0	39.0	63.2	12.3
34.7	4.9	7.3	1.0	73.1	10.3	312.7	44.0	297.9	42.0
-	-	0.2	1.1	-	-	0.5	2.0	3.0	16.2
78.5	12.2	7.7	1.2	20.1	3.1	403.3	62.0	116.3	22.4
26.4	3.3	36.1	4.6	49.3	6.2	555.8	70.4	115.5	14.6
567.5	14.6	606.0	15.6	715.5	(18.4)	1208.9	31.2	2340.5	65.9
175.8	5.6	870.0	27.8	58.5	1.9	1007.0	32.2	1249.4	39.9
258.5	3.2	4739.2	71.8	339.3	4.2	409.8	5.1	7335.7	91.8
0.1	-	-	-	0.9	0.5	150.9	84.0	-	0.6
8.7	1.5	1255.1	89.6	1.0	0.1	1.4	0.0	1399.9	92.5

A detailed breakdown of the sources of import competition for 1979 is given in Table 19. In every category the Far East is the most important source of imports. There is, however, a rough distinction to be made between, first, the more 'traditional' standardised products (portable radios, black and white TVs, simpler music centres, car radios, cassette and tape recorders) and slight modifications of these (clock radios) where competition comes from the NICs and, second, more sophisticated, less standardised products (colour TVs, music centres, hi-fi equipment, car radio/cassette combinations, video recorders) where imports are mainly Japanese. The distinction between 'new' and 'standardised' products is a difficult one to make since the product cycle is very short. Hong Kong has done particularly well in some relatively 'new' products but also in technologically 'mature' products such as clock radios and electronic games. There is also rapid growth, at the margin, of imports from poorer Asian ldcs of some of the simpler products (portable transistors and car radios).

The significance of such a detailed analysis of import penetration assumes that imports compete directly with domestically produced products. Whilst this is true of most consumer items, in the case of TVs the significance of such detailed import penetration figures may be reduced by the possibility that imports from the Far East may not compete directly with the domestic product. This is a result of the large range of possible screen sizes and the operation of the licencing agreement (see Appendix 3 for details) which effectively limits imports of colour TVs into the UK to under the 20 inch (51cm) screen size. As Table 20 shows, in the case of black and white TVs the issue of screen size is unimportant because the main UK market is now in the 12-14 inch screen size (portable) which makes up 92% of the UK market. UK production

Table 20: Distribution of UK market by screen size (%)

Screen sizes	1970	1973	Screen sizes	1976	1979
Colour TVs					
⩽17"	30	4	⩽49cm	12	24
18-20"	30	26	50-53cm	28	25
22"	45	46	54-60cm	47	40
25-26"	25	24	>60cm	13	11
	100	100		100	100
Black and white					
⩽17"	10	47	⩽39cm	79	92
20"	53	25	40-60cm	12	2
24"	37	28	>60cm	9	3
	100	100		100	100

Source: BREMA.

Note: After 1976, screen sizes are given in centimetres.

(mainly by Thorn-EMI) is in direct competition with NIC and Japanese imports. However, with colour TVs the main screen size in the UK market is 21 inch (54cm) and over (50% of the domestic market) which is not in direct competition with smaller screen Japanese and now Singaporean colour TV imports.

Although, as we shall see later, this undermines the case for protection, since 50% of the UK market for colour TVs is effectively 'non-competing', it is nevertheless true that in total the small screen sizes (less than 21 inch or 53cm) now constitute nearly 50% of the UK market and the smallest screen size accounts for nearly 25%. The switch in consumer demand in the 1970s towards smaller screen colour TVs which were not restricted under PAL therefore accounts for the large increase in UK imports in this area.

In order to make some judgement about the performance of the British industry in relation to the different kinds of competition which it faces, a comparison can usefully be made with European countries of roughly comparable size and per capita income. As Table 21 shows, there are strong similarities. First, some areas of production, of radios (portable transistors) and tape recorders, have virtually disappeared in all European countries. Black and white TV production is moving in the same direction, having declined furthest in Germany and most rapidly in Italy. The latter is not shown in the table because in 1979 import penetration in Italy rose from 1% to 22%. Second, no European country except Germany (on a very small scale) produces, let along satisfies, demand for the most rapidly growing area of consumer electronics: video equipment. The extent to which Europe has been left behind in this area by the Japanese is evidenced by the fact that Japanese exports of VTRs (video tape recorders) now exceed in value those of colour TVs while 90% of VTRs sold in Europe have Japanese rather than European (ie Philips)

Table 21: European consumer electronic industries, 1978: Number of units produced and consumed ('000s)

Product	Germany		France		Italy		UK	
	P	C	P	C	P	C	P	C
Colour TV	4,075	2,915	1,300	1,675	1,200	1,325	1,800	1,930
Mono TV	412	1,290	508	720	850	880	690	1,100
Car radio and cassette combinations	2,964	3,000	2,100	1,750	630	670	400	1,740
Radios and combinations								
- battery	536	4,968	1,050	6,540	1,200	4,805	450	5,550
- mains	1,376	2,786						
Radio recorders	na	na	na	na	na	na	na	1,375
Portable record players	1,677	2,384	800	775	700	575	60	100
Music centres and residual hi-fi	(na under mains radio & recorders)		100	885	na	na	393	950
Tape recorders	304	3,037	8	1,500	130	680	250	1,315
Video	90	220	-	30	-	15	-	147
TOTALS	11,422	20,600	5,866	13,875	4,710	8,950	4,043	14,307

Source: MacIntosh European Yearbook.

Notes: P = Production; C = Consumption - 1979 estimates

technology. Third, all European countries are largely self-sufficient in colour TVs, due to the existence of restrictions on the use of PAL licences. But this commercial protection is now coming to an end, and import competition can be expected to intensify.

There are important differences as well as similarities. The German industry towers over the others. The total value of German consumer electronics output far exceeds the combined totals of France, the UK and Italy. Germany is a major exporter (to the rest of Europe mainly) of colour TVs and a wide range of audio and radio equipment. But even in Germany producers are facing a crisis widely regarded as the biggest since the country performed its 'economic miracle'. Behind it is the fierce and unrelenting competition from the Far East '...which has made some fear that the entertainment market may become as heavily dominated by Eastern exporters (mainly Japan) as that for motorcycles, cameras, and pocket calculators'.[39] The UK position is particularly weak in radios and audio products, even granted that the European industry is generally on the defensive in these areas. The UK is, for example, the only significant European country to have virtually abandoned car radio/cassette production.

C. ADJUSTMENT IN STANDARDISED TECHNOLOGY GOODS

For simplicity, a study of the experience of British consumer electronics is divided into two, reflecting the technological distinction which we tried to make earlier in terms of the product cycle.

(i) 'mature' or 'standardised' products have been defined above as those for which demand has become inelastic, competition is increasingly on the basis of price, technology has been

widely diffused and is not easily susceptible to major improvements, and competition is shifting to locations which can offer the advantage of low labour costs (due to the availability of semi-skilled or unskilled labour at low wage rates). This is a fair description of much of the audio products 'industry' and also of monochrome TVs.

(ii) 'growth' products are those for which markets are rapidly growing, and have not yet seen widespread technological diffusion. These range from video products which are in the early stage of a growth phase to colour TVs, which could still be characterised as in a 'growth' phase though they have some characteristics of a 'mature' product. It is on the latter group that the main commercial policy interest centres.

Monochrome TVs, radios, tape recorders and other audio products, particularly the simpler music centres, can be broadly represented as 'standardised' products since product design is well-established and competition takes place mainly through price. As a result it is in these product areas where competition from the NICs, as well as Japan, has been most intense. UK import penetration passed 50% for monochrome TVs in 1979 and was even higher in goods such as music centres (60%) and car radios (85%). Early statistical returns for 1980 indicate even higher levels (75% for music centres) and also the emergence of new 'low wage' producers (particularly Thailand) among exporters of monochrome TVs to the UK. The NICs provided, in 1979, 40% of imported monochrome (small screen) TVs and 20% of imported music centres. Some of these developments are what theory would, by and large, predict as inevitable for a developed country. There has even been explicit recognition in the industry that UK producers could not

realistically expect (even before the recent appreciation of sterling) to compete on price, in these commodities, with NICs: 'in the case of low technology products such as small screen mono TVs even with the most automated methods of production we cannot compete with low wage cost countries like Thailand, Taiwan or Korea'.[40] The industry's spokesmen have explained their response to 'low cost' competition in what, in some respects, sounds like a textbook description of how to adjust: 'the industry's response to this low cost competition was essentially defensive; sectoral retrenchment, withdrawing from manufacture of the products threatened and concentrating UK production on items incorporating higher technology and higher value added (eg colour TVs).[41] The closure of Grundig's audio (cassette radio recorders and dictating machines) factory in Belfast was justified by the management on the grounds that the products would be produced in the Far East at half the cost.[42] The managing director of one of the few remaining audio manufacturers, Fidelity, recently justified a decision to cut back all but a limited amount of clock radio production by stating 'it no longer makes sense to make portable radios, clock radios and radio cassettes'.[43] Similar retrenchment has taken place in the relatively highly efficient German industry: 'portable radio sets are no longer made in Germany and neither are portable black and white receivers and cassette recorders. And few radio recorder combinations are produced though - like cassette recorders - they were originally developed in Europe... An estimated 40% of domestic hi-fi equipment sales are made by producers in the Far East.'[44]

Nonetheless this process of adjustment has not gone entirely smoothly. There has been political resistance to import competition from the Far East expressed by the manufacturers' association, BREMA, by trades' unions, and particularly by the NEDO Sector Working Party for the industry:

'what we are seeing is not a controlled retreat from an exposed position and a regrouping prior to a further advance but a rout'.[45] As a result of their representations there has been a series of measures relating to monochrome TVs (quotas were imposed on Korean and Taiwanese goods in 1978) followed by (indeed, designed to force the conclusion of) voluntary export restraint agreements (VERs) in 1980. The VERs have been extended to take in other products (music centres) and countries (Singapore) and Japan also has a separate set of restraint arrangements dating originally from 1973 and covering both colour and monochrome sets and music centres. Although Hong Kong was originally restrained when quotas were enforced against radio imports in 1963 the colony is not included within the VRA system. In these restrictions, the UK is not alone: France and Italy (but not Germany) have similar measures.

Manufacturers freely admit that 'it is not possible to be competitive with imports, even after introducing the most sophisticated production methods'.[46] The argument being advanced for protection is not therefore based primarily on a hope that the regeneration of the industry is possible, but rather to allow a phased reduction in order to minimise job losses (both directly and in component-supplying industries).

However, as domestic capacity shrinks in these standardised products (in 1980 UK firms supplied only 38% of the domestic market in monochrome TVs, 41% for music centres) and redundancies continue, the strength of this argument must wane. The remaining UK production of monochrome sets is mainly accounted for by Thorn-EMI and Fidelity Radio (who only entered the market in 1980), both of which have concentrated production in small screen portables in direct competition with Japan and the NICs. This represents a much more straightforward argument, namely, to protect

manufacturers' existing investments in product lines which would be uncompetitive without protection. This argument is supported by the more specialised firms (like Radiomobile) or the small if more varied (like Fidelity) which have, as we shall see below, sought (through new investment) to resist import competition vigorously and see protection as necessary on a more permanent basis. However, the position of the manufacturers is ambivalent in this respect since the present VRA system only limits importation of music centres and monochrome TVs whilst operating no restrictions on radios and combinations which larger manufacturers (eg Rank and Thorn-EMI) import from the NICs and market under their own label.

The other element in the argument is that it is necessary to preserve and develop manufacturing capacity until new products can be introduced. The link between the new products and the old is provided by the belief that there is still substantial profit to be extracted from traditional 'bread and butter' products such as monochrome TVs which can be used for reinvestment in new products and for R & D.

The initial effect of the quotas, followed by VERs, was to stabilise the market. The market share of UK firms in protected categories held up in 1978 but has since declined further. This relapse has occurred mainly because of the inherent uncompetitiveness of UK firms in the face of NIC competition. Controls have been made ineffective by the emergence of new Far Eastern competitors such as Thailand and by adaptation of products to a form exempt from restrictions (such as the Taiwanese 3- or 4-in-one sets). Even if evasion were stopped, new producers as they emerge would have to be given a further segment of the market if serious conflict is to be avoided and VERs negotiated. The sense of decline in the UK industry has been greatly intensified by the effect of recession

(the symptoms of which are not easily disentangled from those of greater import competition). In addition to its factory in Belfast, Grundig has carried out a major rationalisation involving a closure of five audio factories. Philips closed a plant at Kings Lynn because of 'fall in demand for music centres and a static market for TV sets which coincided with increased import penetration from the Far East'. Other music centre producers, Thorn-EMI and Rank, have closed factories while 'more than half the companies in the UK audio industry are now on short time working. This is because of a sudden fall in demand.'[47] The closures on the audio side alone have cost 2,000 jobs in the last year with large numbers working short time. The situation in monochrome TVs is less straightforward since there has been a gradual shift over the years, often within the same plant, from monochrome to colour TVs. The job contractions and closures recently reported by Thorn-EMI, Rank, Philips and Decca are probably a response to recession, rationalisation of production and international competition in that order. One side-effect of partial protection of UK monochrome TV production has, however, been to persuade Far Eastern firms to try to safeguard their own export markets by investing directly in the UK. A Taiwanese firm (TaTung) has, for example, acquired a Racal/Decca plant which was closing, with this aim in view. BREMA, however, regards import competition with growing concern and has pressed for stricter and wider quotas at European level (unsuccessfully so far).

The question arises as to whether there is any option for makers of 'standardised' consumer electronics products other than to withdraw from production rapidly or, after some temporary protection, more gradually. One option for firms (but not for UK workers) is to invest in production in low wage cost countries, using the profits for developing new products in the developed countries. This approach has not been favoured by UK firms. One company (GEC)

tried to set up a radio factory in Malaysia assembling there for the UK market, whilst using UK factories for design, machinery and high skill sub-assembly operations. The venture failed because the scale of operations (for the UK market) was too small, and since it was never competitive, despite lower wages, with Hong Kong firms. Instead, GEC, like other major electrical goods manufacturers, prefers to act as an importer from the Far East of products with which it cannot compete. At first sight this appears a more attractive option than trying to extract surplus from protected domestic production (it is also a good deal easier). As far as it is possible to judge, the practice is widespread for radios and combinations, whose importation is not controlled in any way. For the firms concerned this does represent a form of 'successful' adjustment.

A second option is to try (in a way that German radio and other audio firms have done) to maximise whatever opportunities exist for making high quality ('up-market') or specialised products within product areas otherwise regarded as having little promise for mass production. While the British consumer electronics industry has been successful in adjusting to the switch in demand and technological possibilities in moving from radio to monochrome TV and thence to colour TV, it has been criticised for missing some of the possibilities on the audio side: 'the British audio industry which has been significant, lost most of its markets because it neglected the growth areas of the tape recorder, the cartridge and the cassette'.[48] (Although these are also now largely monopolised by Far Eastern exporters even in markets such as Germany.) It is certainly possible to identify some successful specialised firms - making hi-fi equipment and loudspeakers for example - which have followed this route and as a consequence are not particularly concerned about import competition and export most of their output. Larger

'volume' producers, of music centres and hi-fis have also tried to concentrate upon, and design, higher quality 'upmarket' sets, but have found that there is an inherent contradiction in trying to produce on a large scale for a small specialised market.

A final option is to try to exploit microprocessors to make advances in process technology - automation - which eliminate the advantage which NICs and other ldcs derive from low wages. The UK's leading car radio manufacturer has tried to do just this with the help of grants from the government's microprocessor application project. This, claimed the firm, had cut costs by over 20% and made its products 'just about' competitive in price with Far Eastern NICs for a product of higher quality.[49] One disincentive to carrying this type of response further is the limited scale of operation of UK firms, given the very high degree of import penetration (83% in car radios). The firm claimed that if production were expanded it could cut unit costs by a further 6%. It is, however, very questionable whether many of the remaining bits of the audio industry could be resurrected in this way even if they had a larger (protected) market. The same reservations apply less forcefully to colour TVs where the scope for process technology is more obvious and the encroachment of NIC or Japanese imports is much less. To this we now turn.

D. COLOUR TVs

Discussion of the future of the UK colour TV industry has something of the romantic flavour of Custer's last stand; a small column of soldiers too far advanced to retreat but unable to move on, surrounded on all sides by hostile Indians, digging in for a last ditch defence.

The colour TV industry now largely *is* the consumer electronics industry. But it is faced with a difficult future. Colour TVs in the UK and other major Western countries have many of the features of a technologically 'mature' commodity; a market approaching saturation (at 60% of UK households), and a technology which is increasingly being acquired by Far Eastern NICs as well as Japan, currently the major exporters. What has held competition in check in Europe has been the PAL licencing system which has prevented (until this year) non-licencees from exporting to Europe the larger TV screen sizes (above 20 inch). The initials PAL relate to the transmission system which exists for most of Western Europe; the technical detail needed to clarify its significance is given in Appendix 3. In the USA, where different design standards are used and patents have not been with-held, market penetration has been much higher. 1.2m. sets were imported from Taiwan, Japan and Korea by the USA in 1979 out of roughly 9m. consumed. Taiwan and Korea are expanding particularly rapidly in the US market, Taiwan having already overtaken Japan. US sensitivity has been such that quotas have been imposed on imports from these countries.

The UK industry, acting through the Sector Industry Working Party of NEDO, has tried to address itself to the problems presented by the Far Eastern suppliers, and these are considered in quite distinct categories.[50] First, there are Japanese firms which have combined high produce quality with competitive prices resulting from economies of scale due to mass production, which has been allied to highly efficient automated production techniques and good production management. Japanese competition may, however, be a diminishing problem, at least insofar as it entails competition with the UK, since the Japanese are investing in the UK colour TV industry whilst rapidly adapting

their consumer electronics exports into product categories which are not produced at all by British firms and scarcely at all in Europe. Secondly, there is a group of NICs (especially Korea, Taiwan and Singapore) and, eventually, other developing countries which may have the advantages of large-scale production to a lesser degree, and also have low wage costs together with governments eager to promote rapid export growth by overt or covert subsidisation. Third, though so far over the technological horizon, is the possibility of competition from new microprocessor-based products emerging from the USA which could help to make obsolete the currently most advanced UK products.

The response of the industry, supported by the Labour government and not repudiated by its successor, is based on several linked propositions: (i) at present the UK industry cannot compete with any of the above groups of producers in an unprotected market; (ii) current uncompetitiveness is reversible by means of new process innovations (ie automation) and by encouraging the adoption of the best engineering and management practices through inward foreign (Japanese) investment; (iii) the long-term future lies with new products which can be developed in the UK only from a process of evolution out of a successful TV industry. This, in order to survive, will need to be protected against import competition.

Taking this argument step by step, the extent to which UK costs (and those of other European countries) are not competitive with Far Eastern competitors was brought out with stark clarity by a detailed survey of colour TV production costs by the Boston Consultancy Group, carried out in 1978.[51] This showed European costs to be 30-35% greater than in Japan or Korea.

Table 22: Comparable costs of colour TV production

	UK	Japan	Korea	W. Germany
Average man hours per set	6.1	1.9	5.0	3.9
Cost per set (£)				
Direct labour costs	10.6	5.7	1.5	15.1
Material costs	126.0	100.0	113.0	119.0
Overheads	20.0	11.0	2.0	17.0
Totals	156.6	116.7	116.5	151.1

Source: National Economic Development Office.

Since that survey the effect of a rising real exchange rate will have made the above figures very flattering to the UK. Underlying the crucially important difference in materials cost, which is 75% of total costs, is the ability of the Japanese in particular to produce components cheaply. There is also evidence that British components are inferior in quality to those entering Japanese plants as well as more expensive. One explanation is the close relationship between component manufacturers and users, which appears to be closer and more harmonious in Japan. UK firms have been dependent for their tubes on one main supplier, Mullard, a subsidiary of one of their competitors (Philips), or else on imports. Another factor is the much larger scale of operation of Japanese component plants which are both more automated (giving higher quality and cost savings) and able to exploit economies of scale.

And because of the generally more sophisticated electronics industry the most advanced integrated circuits are used, economising in other components, as well as more developed ('pre-converged') tubes.

Economies of scale exist also in set assembly and this is a major contributory factor to Japanese productivity levels (man hours per set being one third the UK requirements). Japanese average factory volume is 700,000 units per annum and rising (the Koreans are also producing in new plants of this size). No UK producer approaches it (the average is around 150,000 units) and only the biggest German factories do so. Moreover, according to Sciberras, 'UK market leaders accumulated a wide variety of chassis as a result of responses to short-term competitive situations. This reduces the opportunities of cost advantages of standardised production even when the total volume of manufacture was very large'.[52] In large plants it is also possible to use advanced automation techniques. In 1978 in Japan 70 to 80% of all components were automatically inserted, as against 15 to 30% in Europe. Automation also permits superior testing of components and, therefore, higher reliability.

The comparison would be invidious enough were it merely a matter of price and production costs. Quality and design - notably in power and ancillary features - have also lagged behind in Britain; this helps to explain the very much more competitive character of the German industry whose costs of production are not much different from those of the UK. One other negative influence is that of the rental companies which account for half of sales and 'acted in the past to retard technical developments in the UK industry. The rental companies' main concern was to hold down costs to their own consumers... by...offering mainly simple sets and through the minimisation of service costs... The means was the rejection of

technical developments which raised both of these types of cost' (the author of this comment now recognises some belated change).[53] Thus, the UK industry is, for a variety of reasons, fundamentally uncompetitive with the Japanese in a free market, whilst potentially vulnerable to increased competition from NICs.

The second stage of the industry's argument is that, given a breathing space, it could achieve Japanese productivity levels. The means would be essentially two-fold. The first would entail the conversion of existing British manufacturing to the automated production methods employed by the Japanese (the Japanese are now exporting the machinery for this purpose to more 'backward' economies like Britain and Germany in an interesting inversion of the traditional flow of technology). This process would be accompanied by measures to rationalise production of both sets and components and generally to improve component quality and delivery. A second development, but linked to the first, was to be the encouragement of Japanese inward foreign investment both to promote the spread of 'best practices' in the UK industry and, rather more, to enlarge the demand for British goods through exports to Europe rather than substitution of the production of UK firms. After some initial hostility, based on a fear that Japanese firms would not use British components, Japanese firms have been actively welcomed and five (including joint ventures) now produce in the UK and account for 30% of output. All have plans to step up output. There are reports already of substantial export growth (mainly by Sony and Toshiba and mainly to Germany). Japanese companies have been welcomed into both the British manufacturers' association (BREMA) and the Sector Working Party of NEDO. The combined influence of these two developments will, it is hoped, 'make the UK a centre of consumer electronic excellence in the medium term'.[54]

It is difficult not to have twinges of reservation about the strategy. Even if the productivity and marketing improvements are realised to the degree required, the new policy rests very heavily on the Japanese companies. The tactical interest of the Japanese is clear enough; they wish to secure access to the European market from which they might otherwise be excluded by import controls. But their contribution in the form of technology transfer is likely to be the minimum necessary to achieve their acceptance in the role of investors (as it is of Western companies investing overseas). In addition, it is perfectly possible that some developing countries will combine Japanese productivity levels with low labour costs for the residual labour content. This could be achieved by 'national' producers in Korea or Taiwan or by subsidiaries of Japanese companies which do not produce in Europe (such as Sharp) in the ASEAN countries. For this reason protection is likely to be an indispensable part of the sector's strategy for survival and is recognised as such.

'The competitive challenge of the NICs'

Although the NICs have a clear competitive advantage in wage costs (Korea's labour costs are only 14% of the UK's) the extent of their current competitive challenge is limited in the short run by lack of the PAL licence and the comparatively poor design and quality of their sets. The former, as we have seen, is a diminishing problem. The latter is a question of obtaining access to the most advanced product and process technology from the leading firms. Some commentators are pessimistic: 'Only simple products such as black and white sets and simple colour portables, using older technology in tubes and semi-conductors are transferred to such facilities' (ie developing countries in the Far East).[55] The same is true of new process technologies, 'with the exception of

subsidiaries of some Japanese firms all assembly in the developing countries was done manually'.[56] The major problem for the NICs is that in order to raise product design and quality standards to European levels, they would need to adopt improved designs with fewer and more advanced components per set. This would reduce the labour component in set production and thereby encourage the adoption of capital-intensive automated production techniques which raise product quality and lower production costs further. There is some evidence that a process of product 'upgrading' is occurring in South East Asian producers both through greater adoption of PAL specifications and (since the mid 1970s) the increased involvement in Singapore of foreign (especially European) multinationals in direct investment, sub-contracting and licencing arrangements. There are also prospects for increased involvement of European companies.

For example, Philips recently declared: 'We would like to be able to close some of these /European colour TV plants/ and concentrate production in one or two locations - and if need be, move production to cheap locations offshore (eg the Far East).....'[57] In fact, Philips already has a portable colour TV factory in Singapore operating within the PAL licence system and as a result there has been rapid export expansion to Europe (Singapore provided 12% of all UK colour TV imports in 1979). AEG/Telefunken has recently reached agreement to produce colour TVs in Hong Kong for export to Europe, and had previously entered into a technical assistance agreement in 1974 with a Singapore firm, 'Roxy Electric', which now produces small screen TVs (20 and 16 inch screen size) in the PAL format. Thomson-Brandt also operates a wholly-owned subsidiary in Singapore (European Standard Electronics) producing portables to PAL specifications. In Taiwan the local manufacturers' association is currently negotiating to buy the patent, but some companies have started handling PAL business

before negotiations have come to an end by shipping partially assembled TV receivers for assembly in Europe: 'In fact, we handle only part of the manufacture and our clients take care of the licencing from Telefunken'.[54] One Taiwanese firm (United Electronics) currently ships partially assembled PAL sets to Hong Kong for final assembly and shipment to Europe. Korean manufacturers have also stated that they may start manufacture of PAL and SECAM standard receivers when they develop the technology for these products and complete negotiations on royalties and licencing. The spread of PAL specifications itself represents an upgrading of NIC product design but it is also becoming apparent that, due to the pressure of local competition, product sophistication and quality have been rising anyway both in Korea, where 'established makers of CTVs have plans to upgrade their product lines...by introducing new models with high end features'[59] and in Singapore, where new models have fewer components and increasingly sophisticated optional features such as sensor touch switches, remote control devices and stereo sound. Where manufacturers have sufficiently high plant volumes the level of automation is also increasing. For example, Hitachi Singapore (whose main markets are the USA, the UK and China) have currently embarked on an ambitious plan to double the current annual level of colour TV production to over 300,000 units which will be produced with automated production techniques. The latter include computer controlled automatic circuit board assembly systems and component sequencing equipment. Current expansion plans by Singaporean manufacturers will increase total CTV output by 700,000 in the next few years and with f.o.b. prices for PAL sets ranging from 235 US$ for 14 inch sets to 370 US$ for 20 inch sets they are likely to remain highly competitive. For various reasons then, the UK industry is not only fundamentally uncompetitive with the Japanese but may well face increasing import competition from South East Asian NICs during the 1980s.

The role of protection

So far the question of protection against exports of colour TVs from developing countries has not arisen. The only restrictive device in place is the VER on Japanese exports. It is not, however, liberalism which has kept open the UK market but the protection accorded by the PAL licencing system (and, more indirectly, by the protective effect of a special relationship between UK manufacturers and rental sale companies). The industry and the UK authorities have made it clear that they regard the network of trade restrictions being built up on audio and monochrome TVs as extendable to colour TVs as problems arise: 'it is intended that these agreements should continue and that the arrangements should be progressively firmed up, bringing in more countries and products as and when necessary.'[60] How soon action will be required will depend on how quickly PAL technology is transferred to the NICs, and that in turn depends largely on the behaviour of the large CTV firms which are the repositories of technical knowledge.

As we have seen (p.95), the colour TV industries of Korea and Taiwan are already eyeing the European market. One Taiwanese company has invested in an assembly plant in Ireland to duck under any future EEC protection (and without the safeguards on local component use agreed with the Japanese in the UK). Thus protection against NICs is very much on the agenda even if the issue is not currently a live one.

The case for protection could be broadly characterised as one of temporary protection to permit the rejuvenation through process innovation of an industry which, if not 'senile', is approaching advanced maturity. This raises two questions. First, is the rejuvenation possible?

Second, is it desirable for the government to extend protection in order to help make it possible, As to the first, there is no sign as yet of production being carried out on the scale - of plant - comparable to that of the main producers. But while undoubtedly on a small scale in international terms, substantial investment in advanced automated equipment and rationalisation is taking place (by Thorn-EMI, GEC/Hitachi, Philips, Decca, and Rank). The advent of Japanese companies has raised productivity and managerial performance in the industry. There are reports of significant improvements in component supply and prices. These changes have been carried out under a 1979-84 strategic plan for the industry, in which the promise of protection was a key element. Until the mid-1980s it will not be possible to judge whether the industry has been made internationally competitive.

What are the costs and benefits of this strategy, The costs are clear enough, if not all that easy to measure: loss of consumer surplus plus the direct resource cost and the opportunity cost of financial support by the government and the longer term consequences for economic growth of inefficient use of resources if the strategy should fail. But to offset this are the costs of allowing the industry to decline, and, *in extremis*, to disappear. These costs are both direct and, rather more important, indirect, and are felt immediately in terms of employment. The numbers employed in colour TV assembly are, however, not large, possibly 25,000, with a further 4,000 making colour TV tubes in the Mullard factories, mainly in Durham. The majority of the workers are unskilled women and, except in one or two locations (eg the Rank/Toshiba plant in Cornwall), there are no exceptional problems of labour adjustment. The small size and the occupational character of the labour force make it an unlikely focus for worker resistance. However, the manual workers have members in two of Britain's major unions, the TGWU (the largest)

and the EETPU, while the technical staff are represented predominantly by the TASS division of the second largest union (the AEUW). The combined influence of these unions is considerable - a large number of Labour MPs belong to them - and they have thrown their campaigning weight behind the NEDO SWP plan to 'save' the consumer electronics industry. It is doubtful, however, if employment considerations are decisive. The planned automation of the industry will take a heavy toll of the remaining labour force (offset to some extent by additional jobs provided by the export activities of the Japanese companies). The interest of owners of capital in protecting their investments - which was probably always more important - will increase relative to that of the unions as they have now sunk a good deal of additional capital into labour-saving equipment.

The indirect costs are to be found in the inter-relationship of consumer electronics and components producers. It is argued that if the consumer electronics industry were to decline it would 'drag down' large parts of the components industry with it. Consumer electronics is, after all, an assembly operation and most of the value added lies in the supplying industries. The share of purchases of inputs in total sales value has been (for all consumer electronics) in the range 65-75% in recent years, representing the lowest value added of almost any manufacturing industry. As Table 23 shows, audio components and TV tubes account for 46% of the value of UK components production. And, as noted above, a good deal of effort has been put in by components manufacturers to improve supply to the industry. The most vulnerable to any contraction of colour TV production is the sole manufacturer of colour TV tubes, Mullard (following the closure of Thorn-EMI's Skelmersdale plant in 1976). Major investment (a £24m. programme) has been made by Mullard, with government backing in the form of grants, in improving productivity,

Table 23: Value of UK component content in brown goods, 1979 (£m.)

Product	Component		
	Cathode ray tubes	Other electronic components*	Total
Colour TVs	57	33	90
Black and white TVs	-	9	9
Audio	-	22	22
TOTAL sold to UK consumer electronics industry	57	64	121
% of total UK components industry sales*	6.5	7.3	13.7
% of home market component sales	13.8	15.5	29.2

Source: NEDO estimates based on information supplied by ITT Components (UK) Ltd and Mullard Ltd.

Note: * Total UK components sales figures exclude products not defined as 'electronic components' in column two, ie, sales total for MLH 364 (£1204m) less unclassified sales, waste products not defined as 'electronic components', ie, video and audio tapes and discs, record playing mechanism and accessories, microphones, loudspeakers, aerials, knobs, magnetic recording heads, tuners, etc.

and it is expanding its share of the UK tube market (currently 50%). It already faces direct competition in some lines (from Singapore notably) and does not produce others (14 and 16 inch tubes for portable TVs - arguably the most rapidly growing sector of the market). UK component suppliers naturally dramatise the costs of losing their markets; the other side of the coin is that assemblers could benefit from cheaper inputs.

Although the inter-relationship between components and consumer goods is strong, and currently crucial to both, it will arguably become less important over time, even if colour TV manufacture holds its ground. One reason is that the application of product redesigns and new micro-electronic components is greatly reducing the need for components in TV sets. It is estimated that advanced Japanese designs use about 400 components as against 600 in UK-made Japanese sets and over 1,000 used in British sets. The reduction in value may be less than in quantity but it is occurring in absolute terms as well as in relation to other forms of equipment demand. With new uses for main circuits and associated equipment being found and developed, the relative importance of audio and TV electronics will be further reduced, the more so as final demand for these items is also increasing relatively slowly. The latest European electronics yearbook forecast is that the demand (both in the UK and Europe generally) for integrated circuits and microprocessors will rise by 16-20% per annum even in a period of recession, the main source of demand being in computers and peripherals. Finally there is doubt over the extent to which colour TV manufacturers will, in any event, continue to buy British. The Japanese companies have given assurances that they will do so, but these assurances are not legally binding and depend heavily on good-will. Moreover, as other UK and European companies find themselves competing against these Japanese companies as well as each other in the European market they may well be driven to global 'sourcing' in order to minimise costs.

Thus the linkage between TV production and components is important but of diminishing force.

A final consideration is that protection, to be effective, will have to operate on a European rather than a national basis. BREMA has already pressed for European controls to strengthen the restraint arrangements against imports from NICs of black and white TVs and audio equipment, in order to prevent transhipment and erosion of the European market at its most liberal point of entry. Separate efforts have also been made to devise a common European policy on imports of colour TVs from Japan. There are, however, fundamental disagreements between the major companies and no agreement has been reached.[62] The main lobby for protection (against colour TVs from Japan) came from Philips which has the biggest share of the large German market and is potentially the most vulnerable to competition when the PAL licences have expired. The main UK companies are lukewarm, having achieved what they consider to be a satisfactory arrangement with the main Japanese firms, which are 'good British citizens' and are cutting into the German market from the UK. The UK (and Japanese) firms in Britain are also anxious not to become dependent on Philips for colour tubes because of import controls on Japanese tubes. The British are more worried about the NICs, while the Continental companies appear to regard offshore production in the NICs as a counter to the Japanese. These differences between 'company' and national, let alone European, interests promise to make the emergence of a consistent and clear trade policy very difficult. In the meantime, the European Commission is considering a compromise which would give a promise to importers of free trade in five to seven years in return for temporary, 'voluntary', restraint on Japan.

E. NEW PRODUCTS

The major argument for continued protection of the existing consumer electronics industry centres around the belief that protection will ensure the preservation of the so-called 'bread and butter' activities such as colour TV production in order to generate profits, and also maintain a large nucleus of technically skilled personnel, both of which are required for launching new products. To some extent the innovative drive in consumer electronics has originated not in free market competition but in the ability of innovators to create and protect, through patents or other restrictions on market access, a temporary monopoly sufficient to realise a satisfactory profit on their investment and a basis for further growth. It is tempting for firms to argue that it is but one short step along the same road for governments to intervene by means which are a logical extension of the principle behind patent licencing. The argument has several distinct but inter-related parts.

First, according to the major firms, there is a need to generate sufficient profits on existing products in order to finance research and development (leading to product innovation) and to underwrite any future investment plans. According to the UK's leading manufacturer, the VRA system prevents 'a reduction of main factory loading' which would 'reduce profits per unit on colour TVs' which is the main source of 'resources for reinvestment and R & D in new products'.[63]

The second part of the argument relates to the need to preserve the existing nucleus of labour skills and plant infrastructure from which new products can grow 'organically' in the future. For example, NEDO has recently claimed that in order to launch a generation of new video products 'any production depends on the continued existence in the short and medium term of the plants and expertise which are currently so vulnerable to overseas competition'.[64]

The earlier loss of the radio industry is also said to exemplify the relationship between established firms and new products; 'the UK is facing difficulties in the consumer goods area by our inability to competitively produce clock radios and other radio combination products after losing our radio industry'.[65]

There is also a need to take account of the 'strategic' role of the consumer electronics industry in the predicted convergence between electronics, computing and telecommunication technologies in what has become known as 'telematics' or 'information technology'. The main function of this technological convergence would be to handle and process information quickly and cheaply and it is predicted to be a major growth area in the future (the market in electronic data processing is currently growing at 21% each year). The main role of the existing consumer electronics industry would be to provide hardware for the 'home electronics' system of the future. To some extent this is already occurring in systems currently under commercial operation in the UK. These include the Post Office's 'Prestel' system which uses modified domestic colour TVs linked to data bases via the telephone network and the BBC/IBA 'videotex' services in which the domestic TV receives frames of information which are broadcast on channels using space not taken by conventional programmes. If predictions about the future growth of 'telematics' are accurate, it is arguable that 'it is important that the UK retains a consumer electronics industry because without it we stand to forego major opportunities in several sectors of the electronics 'industry'.[66]

To the extent that the existing industry would be required to produce a new range of product innovations built around 'home electronics' this broader argument is closely related to those concerning the need to retain existing manufacturing capacity in order to ensure

the emergence of new products. According to BREMA the sort of problems that might arise is indicated by the difficulties that the UK is facing in establishing a word processor industry (another 'telematics'-related activity). The new generation of products that would be expected to emerge from the existing consumer electronics industry would move beyond the 'stand alone' products such as colour TVs and Video Cassette Recorders (VCRs) and would be fully integrated into the home or business electronics systems of the future. Suggested product areas are viewdata receivers, homefax, home computers and peripheral hardware, alphanumeric keyboards, slave displays, hardcopy printers, and bulk data stores. Although the technology for these products already exists it is presumed that the UK can only exploit advances in these areas through utilising the advantages of the existing consumer electronic firms.

There is thus an implicit positive association between protection and product innovation, 'if protected it /the consumer electronics industry/ will become more efficient and innovative, more prepared to adapt and invest...'[67] There is, however, an entirely different interpretation which could be put upon the role of protection in a technological environment which is so rapidly moving. This is that it removes from the UK colour TV companies any urgency behind the need to adapt if they are to survive. For example, in both the UK and German industries, despite having a protected quasi monopoly in colour TV for many years, hardly any effort at all has been made to develop a video products manufacturing industry. One commentator has attributed the failure of Germany to innovate more aggresively precisely to the 'quasi monopoly position in the most lucrative consumer electronics field, namely colour TV, which is still protected thanks to the PAL patents... While the Germans were milking that field and doing little to open up new ones the Japanese established hi-fi equipment and video cassette recorder markets.'[68]

(The Japanese dominate the video field with 700,000 out of 800,000 European sales - the remainder coming from Philips and Grundig.)

There are also severe problems involved in the contention that new products can be expected to grow organically from the existing manufacturing base. Firstly, in the case of the future establishment of VCR production in the UK, it is conceivable that existing firms could simply be by-passed if the leading Japanese or European firms favoured direct investment in the UK and set up brand new production facilities. On the other hand, the strong market share of Thorn-EMI in this product (the company currently imports and markets VCRs made by JVC of Japan) makes it increasingly likely that future UK production will take the form of a licencing arrangement. This would probably involve an initial stage where Thorn-EMI assembled imported kits and supplied components (such as printed circuit boards) for which it already has the capacity, and later the company would also produce more advanced structures such as the precision made chassis and recording head assembly. In this sense the future production of at least this new product may well emerge from an existing UK company. But that is not the only feasible route, and, moreover, the technology is predominantly imported.

The argument about the 'organic link' between new products and the existing consumer electronics industry is on weaker ground in the field of 'telematics'. It is true that existing colour TV producers have made an important contribution to the setting-up of the world's first public 'videotex' services by collaborating with the Post Office, the BBC and the IBA in the development, production and distribution of viewdata and teletext receivers. (The UK currently has a technical lead of about two years over its nearest rivals.) However, there is no reason *a priori* to presume that new product innovations in this area

either for home or for commercial use will necessarily arise solely or even predominantly from the established industry. For example, product innovation is often associated with the birth of new firms. A good example of this is the recent introduction by a new firm 'Technalogics' of an adaptor which can be attached to existing colour TVs and is capable of interpreting 'viewdata' and 'teletext' signals. The product is thought to have major potential for the US market and mass production would probably reduce its initially high retail price of £250. Another example of a relatively new dynamic firm is 'Science of Cambridge' which has recently introduced a range of inexpensive mini-computers which function by using the domestic colour TV as a visual display unit. The firm currently produces more than 129,000 units per annum and 70% of production is exported. Plans have also recently been announced to produce pocket-sized TV sets at a 'green field' factory site with a planned output of up to one million sets per annum.

It is apparent then, that although there are some grounds for arguing that protection of the existing industry provides a base for the development of advanced products in the UK, the case cannot be taken entirely at its face value. It may not always be an efficient use of resources to try to develop a complete range of new products rather than to import the technology. And if technology is to be imported there may be more efficient means of technology transfer than for UK companies to import under licence (for example, direct foreign investment in the UK). In growth areas of the economy such as 'telematics' where innovation rates are high, the main initiative is likely to be taken by new small firms.

Nevertheless, we do recognise that there may be a stronger case for adopting 'infant industry' protection on new products. For example, import restrictions on VCRs

might have the effect of securing a potentially large domestic market for UK producers which would make it profitable for UK firms to manufacture under licence. 'Infant industry' protection could conceivably also encourage direct investment by Japanese firms in the same way, who might seek to secure access both to the UK and European markets in the same way they apparently did in the colour TV industry. Paradoxically, the leading UK companies may not find such an approach in their own interests. Thorn-EMI, for example, has used its rental chain to obtain 42% of the UK VCR market with machines imported from Japan and marketed under the company's 'Bush' and 'Ferguson' labels. In this situation infant industry protection would probably damage the interests of Thorn-EMI as an importer, at least in the short-run.

Conclusions

The first major point emerging from a study of the consumer electronics industry in relation to competing trade between ldcs and at least one developed country is the ambiguity in the concept of 'adjustment'. Governments of developed countries are frequently lectured by international agencies (and the present authors among others) about the need for 'positive adjustment' to international competition rather than protection - in other words, working with the grain of market forces rather than against. But 'positive adjustment' can be reasonably held to mean various things. The virtual disappearance of most branches of audio production in the UK in the face of competing developing country and, earlier, Japanese imports could be regarded as a form of positive adjustment and a manifestation of the UK's changing comparative advantage. Some mobile resources have been redeployed elsewhere (in the making of TVs) and immobile assets, capital and labour skills have presumably been written-off. But there is also a case for saying that firms could have reacted far more 'positively' by adapting and upgrading audio products to meet the continuing demand for new products which has characterised the audio scene. This process has happened to a much greater degree in Germany. A more radical definition of 'adjustment', applicable to larger firms, could include the possibility of redeploying resources outside the industry narrowly defined, from consumer to medical electronics or office automation, or from video equipment to softwear and accessories. Another form of adjustment is for producers to participate themselves in the international division of production by means of overseas investment, subcontracting or

acting as importers. These activities might well be profitable from the viewpoint of company shareholders but are less likely to be seen as an acceptable form of adjustment by (developed country) workers. All of these are valid, but different, responses by private firms acting largely independently of governments.

Almost all governments, however, have been singularly reluctant to leave the allocation of resources to market forces. They are under constant pressure from businessmen to help them reduce uncertainty and minimise competition both from new and existing industries. Thus, Lord Thorneycroft, Chairman of the British Conservative Party, and generally a trenchant advocate of more radically free market policies, pleaded for his own consumer electronics industry, 'industry to industry talks are necessary for... sensible planning on an international basis of how we manage to trade without doing great damage to one another'. It is thinking along these lines which has prompted a different version of 'positive adjustment'; investment supported by trade protection to transform the process of production of existing products, making it more capital-intensive and less vulnerable to competition from lower labour cost exporters. This approach is currently being followed by the UK (and in varying degrees by other developed countries) in respect of colour TVs and in some residual audio activities. Our instincts are to regard this as of questionable merit since it runs the familiar risk of being drawn into the permanent subsidisation of protection of an industry which is no longer competitive. If governments are to intervene there seems more future in actively promoting or subsidising new rather than established products, as appears to happen, for example, in Japan. But we are conscious of the force of the argument that new products are often developed as part of a gradual evolution from an existing industrial base and of the considerable advantages that existing manufacturers may have.

A second theme to emerge is that, while there is a certain amount which is specific to British experience, there are similarities with other developed countries of similar size and income, especially in Western Europe. These countries could be characterised as 'early technological followers' with the main innovations being made elsewhere in the USA, and increasingly in Japan, but enjoying a period of growth in the home markets of 'early followers' before 'late followers' in the developing countries catch up. The evidence of a shortening 'diffusion lag' between innovation and widening dispersion of technology does, however, raise questions about the viability, let alone the stability, of such a form of specialisation. In practice, governments of these countries have intervened, some more extensively than others, to promote new products and to resist the disappearance of production to lower wage-cost, less technically sophisticated countries. One way in which this study could be taken forward would be its extension to make a comparative analysis of countries facing comparable problems and choices to those of the UK. Germany and France are the obvious candidates for such a comparison, the more so as their governments come together with those of the UK (and others) to formulate joint European policy. But similar concerns will undoubtedly be found in Sweden, Canada, Italy, Australia, and elsewhere.

Third, although this study has not been primarily concerned with the details of developing country consumer electronics industries, and electrical engineering more generally, several questions have been raised which need to be pursued. Perhaps the most important relates to the extent of net benefits which ldcs derive from their export industries, particularly in the electronics field. There are essentially two views which can be crudely caricatured as follows. The first regards the expansion of these exports as beneficial from the standpoint of employment and foreign-exchange earnings and regards with equanimity

and even enthusiasm the prospect of their rapid growth. There is also optimism about the possibilities of ldcs developing a gradually more sophisticated and independent electronics export capacity. The second, more critical view is that this form of export expansion is 'dependent', contributing little or nothing to development, is exploitative of labour, and has its apparent benefits negated by the wider economic and political costs of policies being tailored to attract foreign investment. On this interpretation the involvement of ldcs in international specialisation is only transitory and insecurely based. The underlying assumptions behind these two views are so fundamentally different that it is difficult to see how they can be reconciled to explain even the same sets of facts. Our assessment would be that the net benefits to current major exporters of electronics goods really are substantial but that there are dangers of extrapolating forward in time and to other countries. There are certainly genuine doubts about how far even the most sophisticated of the NICs can develop into the more technologically independent, higher value-added production to which they aspire. And the possibility that producers in developed countries are capable of 'saving' their industries by adopting highly capital-intensive methods derived from process innovation is a warning to governments in ldcs which believe in the irreversibility of comparative advantage and may be unwittingly drawn into subsidising international competition to use the most advanced, labour-saving machinery. Moreover, these effects on manufacturing assembly operations form but a small part of the complex systems being developed around electronics almost exclusively in the industrialised nations.

Nonetheless, we tend to a generally optimistic view of the capacities of the NICs in adapting to future changes, though we are more sceptical about the possibilities of other relatively poorer and more populous developing countries following in their footsteps. There are possibilities for Asian and African countries trying to reproduce the history of the Far Eastern NICs in this sector, but the expectations of many of their governments may be quite excessive.

FOOTNOTES

1. More general analysis of UK adjustment experience is provided in *The Newly Industrialising Countries: the Adjustment Problem*, Foreign and Commonwealth Office, and ODI, 'Adjustment to North-South Trade in the UK Economy' in G. Renshaw (ed.), *Employment, International Trade and North/South Cooperation*, International Labour Office, forthcoming.

2. There is little relevant literature on the general problem but it is dealt with *inter alia* in S. McDowall and P. Draper, *Trade Adjustment in the British Jute Industry: A Case Study*, ODI/Fraser of Allander Institute, 1967.

3. NEDO (National Economic Development Office) SWP (Sector Working Party) on *Consumer Electronics Progress Report, 1980.*

4. NEDO, SWP, *Progress Report, 1978.*

5. H. K. Hoffman and H. J. Rush, 'The Impact of Micro-electronics in the Third World - Problems and Potential in Restructuring British Industry', in A. Riddell (ed.), *Adjustment or Protectionism*, Catholic Institute for International Relations, London, 1980.

6. Gnostic Concepts Forecasts in 'Electronic Business in the 1980s', *Electronics Business*, December 1979; also '"Interfutures": Facing the Future', *OECD Observer*, September 1979, pp.29-30.

7. Economist Intelligence Unit, 'Chips in the 1980s', *Special Report No. 67*, July 1979.

8. For a study of comparative advantage incorporating technological factors see S. Hirsch, *Rich Man's, Poor Man's and Every Man's Goods - Aspects of Industrialisation*, Mohr, Tübingen, 1977. The literature on the product cycle is vast but the key contributions as they relate to trade include G. Hufbauer, *Synthetic Materials and the Theory of International Trade*, Harvard University Press, 1966; S. Hirsch, 'The Product Cycle Model of International Trade', *Oxford Bulletin of Economics and Statistics*, 1977; Raymond Vernon, 'International Investment and International Trade in The Product Cycle', *Quarterly Journal of Economics*, 1966; M. V. Posner, *International Trade and Technical Change*, Oxford Economic Papers 1961. On the product cycle as applied to developing countries, see A. Sen, 'The Followers Strategy for Technological Development', *The Developing Economies*, Vol. 17, December 1979.

9. L. Nasbeth and G. Ray, *The Diffusion of New Industrial Processes*, Cambridge University Press, 1974.

10. A. K. Sen, *op. cit.*

11. R. Vernon, 'The Product Cycle Hypothesis in a New International Environment', *Oxford Bulletin of Economics and Statistics*, November 1979.

12. J. Rada, *The Impact of Microelectronics*, International Labour Office, Geneva, 1980, pp.87-88.

13. *Ibid.*, p.266 based on, *inter alia*, Sanjaya Lall, 'Developing Countries as Exporters of Industrial Technology', *Research Policy*, Vol. 9, No. 1.

14. V. Cable and I. Rebelo, 'Britain's Pattern of Specialisation in Manufactured Goods with Developing Countries and Trade Protection', *World Bank Staff Working Paper No. 425.*

15. K. Pavitt, *et al.*, *Technical Innovation and British Economic Performance* - Introduction and Summary by Pavitt - Macmillan for Science Policy Research Unit, London, 1980. See also, K. Pavitt, 'Technical Innovation and Industrial Development - the dangers of divergence', *Futures*, February, 1980.

16. E. Scibberas, 'International Competition and the UK electronics industry', *Electronic Engineering*, March 1979, p.182.

17. C. Freeman, 'Technical Innovation and the British Trade Performance' in F. Blackaby (ed.), *Deindustrialisation*, NIESR, 1979, p.72.

18. R. Vernon and W. H. Davidson, 'Foreign Production of Technology - Intensive Products by US-Based Multinational Enterprises', *Working Paper 79-5*, Harvard Business School, 1979.

19. *Report of the Advisory Committee on Diversifications*, Hong Kong Government, 1979, Chapter III.

20. Scibberas, *op. cit.*

21. *Report of the Advisory Committee on Diversification, op. cit.*

22. 'Survey of Korean electronics', *Journal of Asian Electronics Union*, March 1980.

23. *Electronic Business*, July 1980, p.108.

24. Information supplied to the authors by S. Lall.

25. Bela Balassa, 'The Changing International Division of Labour in Manufactured Goods', *Banco Nazionale del Lavoro Quarterly Review*, September 1979, based on World Development Reports. See also, P. Plesch, 'Developing Countries' Exports of Electronics and Electrical Engineering Products', *Working Paper*, Economics of Industry Division, Development Economics Department, World Bank, Washington DC, 1978.

26. *Journal of Asian Electronics Union* (AEU), March 1980.

27. *Ibid.*, February 1980 (and various editions of the *Journal of Asian Economics Union* for other details).

28. *Journal of the Electronics Industry* (published in Japan), October 1980 (and various other editions for other details).

29. 'Hong Kong Survey', *Journal of Asian Economics Union*, October, 1979.

30. *Ibid.*, May 1980.

31. *The Economist*, September 6, 1980, p.68.

32. S. Lall, 'Transfer Pricing in Assembly Industries' in 'Industrial Cooperation', *Commonwealth Economic Papers*, No. 11.

33. R. Grossman, 'Bitter Wages - Women in East Asia's semi-conductor plants', *Multinational Monitor*, 3, 1980. See also F. Frobel, *et al.*, *The New International Division of Labour*, Cambridge University Press, 1979, especially part III.

34. For historical background on the industries of these countries, their strengths and weaknesses see, UNCTAD, *Electronics in Developing Countries: Issues in Transfer and Development of Technology*, TD/B/C.6/34, 1978.

35. *Control Imports Now*, a Transport and General Workers Union Research Booklet, p.36.

36. NEDO Sector Working Party *Progress Reports*, 1980, on 'Electronic Components', 'Domestic Electrical Appliances'; also *Control Imports Now*, *op. cit.*, chapter 5 - 'Electrical and Electronic Goods - The Import Threat'.

37. NEDO SWP, *op. cit.*, 'Domestic Electrical Appliances'. Sources in January 1980 issue of *Journal of Electronics Industry* suggest that with reference to Japanese subsidiaries making refrigerators in ASEAN countries 'there has been a remarkable increase in third country exports from South East Asia. It appears that the overseas strategy for refrigerator makers will be to step up overseas production networks based in South East Asia and use them for eventual expansion into the American and European markets.'

38. NEDO, SWP, *Electronic Components Progress Reports*, 1978 to 1980.

39. 'German Consumer Electronics Firms Face Bad Times', *Electronics*, September 11, 1980.

40. *Memorandum on behalf of the NEDO SWP to Secretary of State for Trade*, p.3, 1980.

41. *Ibid.*, p.1.

42. Notes of a meeting held at national level between Grundig (Northern Ireland) and the EETPU, AUEW and ASTMS.

43. Quoted in *Electrical and Radio Trading*, November 6, 1980.

44. *Electronics, op. cit.*, September 11, 1980.

45. *Memorandum, op. cit.*

46. *Ibid.*, p.3.

47. Various references in *Electrical and Radio Trading*, Summer 1980.

48. Comment by George Ray on Freeman paper in F. Blackaby (ed.), *op. cit.*

49. Submission by Radiomobile (UK Ltd.) to the government, July 1980.

50. NEDO, Electronics Consumer Goods SWP, *Progress Report*, 1980, p.1.

51. Consultancy report by Boston Consultancy Group carried out for NEDO.

52. Scibberas, *op. cit.*, p.189.

53. *Ibid.*

54. NEDO, SWP, Consumer Electronics, *Progress Report*, 1980, p.1.

55. E. Scibberas, 'Transfer of Technology in the Consumer Electronics Industry - The Television Sector' unpublished OECD Document, September, 1979.

56. *Ibid.*

57. Quotations from Mr. Cor-van der Kluft in *The Economist*, June 28, 1980.

58. *Asian Sources, Electronics*, (Trade Magazine), November 1980, p.10.

59. *Ibid.*

60. NEDO, SWP Consumer Electronics, *Progress Report*, 1980, p.5.

61. I. C. Magaspirer and T. M. Mont, *Japanese Industrial Policy*, Policy Studies Institute, Study No. 585, January 1980, p.51.

62. *The Economist*, August 25, 1979, pp.46-47, and June 28, 1980, pp.81-82.

63. Interview with Thorn-EMI.

64. *Memorandum, op. cit.*, p.7.

65. *Ibid.*, p.7.

66. Letter to Secretary of State for Trade from Mr. Griffiths of Pye.

67. *Memorandum, op. cit.*, p.9.

68. *Electronics, op. cit.*, September 11, 1980.

APPENDIX 1: ELECTRICAL ENGINEERING AND ELECTRONICS: A SIMPLE CLASSIFICATION

A substantial problem in the way of systematic analysis of electronic products in international trade is the fact that the technology, which has created the rationale for trade, has far outstripped the ingenuity of statisticians to measure its effects. Official trade and industry classifications are largely obsolete and incapable of capturing either the breadth or the detail of current developments.

Official production statistics (like trade statistics), both British and others, do not distinguish between 'electronic' and other 'electrical' goods. Electronics is one form of electrical system - all electrical systems derive from flows of electrons in the form of an electric current - but electronics has two distinguishing characteristics:

a) electronic circuits handle very much smaller currents;
b) they incorporate 'active' components capable of modifying the flow of electricity.

It is primarily the incorporation of 'active' components which is the determining factor as to whether a product or system is 'electronic' or not. The traditional industrial classification of production, both in the UK (MLH) and the international (ISIC) system on which it is based, is in terms of products which form part of the 'electrical engineering' industry. This 'industry' now corresponds very imperfectly to technological boundaries (though it does, reasonably well, conform to the interests of companies, since most 'electronics' has in the UK, though not in the US, grown out of established electrical engineering firms). A rough division between bits of the industry in terms of electronics versus electromechanical processes can be made as follows:

Predominantly electromechanical*	Predominantly electronics*
361 Electrical machinery	
362 Insulated wires & cables	
	363 Telecommunications equip.
	364 Radio & electronic components
	365 Electronic consumer goods
	366 Computers
	367 Radio, radar, electronic capital goods
368 Electrical appliances for domestic use	
369 Other electrical equipment (for motor vehicles, cycles and aircrafts; batteries; light fittings; wiring accessories; lamps).	

* 3-digit MLH headings.

This distinction is, however, inadequate for several reasons:

a) there are numerous, and increasing, electronics uses outside of 'electrical engineering'. Several other industries are substantially electronic: 338, office machinery (notably calculators); 352, watches and clocks (digitals); 354, scientific and industrial instruments and systems. Other sectors such as toys and games are also moving in the same direction.

b) there is a continuous process of displacement of electrical devices by electronics within the categories described above. For example, a large number of electrical appliances, such as microwave ovens, now have electronic controls.

It is perhaps useful to list the main categories of electronics goods without trying to fit them into a

manufacturing census classification for which they were ill-defined, and these are broadly the categories used in the text.

1)	Computers, and business equipment	computers and related (data terminals, etc.) calculators automatic typewriters accounting machines and cash registers
2)	Communications	radar and navigation aids radio communications
3)	Telecommunications	telephone switching and transmission systems
4)	Medical equipment	X-ray and medical equipment
5)	Control and instrumentation	process, motor and machine tool instruments controls (a distinction can be made between users in the auto industry, other industries and professional instruments)
6)	Consumer goods	TV (colour and black and white) video recorders and related products audio - radios (car, clock, novelty, portable, citizen band) - music centres - hi-fi equipment - tape recorders/cassettes - gramophones - clocks and watches - alarms - games and toys - video - handheld - electronic music instruments (eg organs)
7)	Components	active components - discrete semiconductors, transistors, diodes, etc. - integrated circuits - tubes

/ . . . continued

passive components* and
electronic devices
- resistors (impede electric current)
- capacitors (store electronic charge)
- coils (self-inductive)
- other electrical components (connectors, relays, switches, terminals, transformers)
- printed circuit boards

*(although not strictly 'electronic', these components are used in conjunction with 'active' components, and cannot in practice be classified separately from 'electronics').

In conclusion, it should be stressed that by seeking to classify electronics goods in terms of manufactured products we greatly reduce the potential importance of electronics, since:

a) electronics modifies *processes* as well as *products*. Textiles, oil refining and car assembly all increasingly benefit from electronics.

b) the above categorisation refers only to the manufactured *hardware* not to the accompanying *software*. Softwear is treated statistically as a 'service' but is in fact inseparable from the manufacture and is often of greater significance in value terms.

c) a combination of hardware, softwear, new processes and products can produce a whole new electronic system - like a fully automated office, or store.

APPENDIX 2: ELECTRONICS, A BRIEF GUIDE TO THE JARGON

Electronics originated in a succession of inventions, or adaptations of 'active' electrical components capable of modifying the flows of electronic current. The first stage was the use of vacuum values and tubes in radios. This device was, however, limited in its usefulness by its bulk, fragility and uneconomic use of power. The development of electronics in its modern form is primarily due to the invention of semiconductors, made of solid materials, typically silicon, which are capable of transmitting current in a more compact and manageable form than through vacuum tubes.

- the first semiconductor devices were discrete. *Transistors* were invented in 1947. Transistors, together with diodes and resistors, are the main 'active' electronic components.

- in the early 1960s *integrated circuits* (ICs) were introduced (after being invented in 1959). These combined a set of discrete devices on a small piece of silicon. Initially, 10 transistors per silicon chip would be typical.

- in the late 1960s medium- and large-scale integrated circuits (LSI's)were developed connecting hundreds of ICs.

- the culmination of this later development has been the development of very large-scale integrated cirucits (VLSIs). Currently up to 100,000 components can be combined on a small silicon chip. Laboratory testing is being carried out to permit 1m. or even 10m. components per chip. The key feature of these successive advances is in the compression of increasingly small components on to a diminishing area.

The development of large-scale integrated circuits has fostered a development qualitatively, as well as quantitatively, different. This is the *micro-processor*, introduced first in 1972. The micro-processor is a complex integrated circuit (on a 'chip') with the additional feature of a data-processing capacity. This capacity derives from components which give the device the ability to carry out logical and arithmetic functions. Thus the chip has the programmable properties of a computer and can enable it in combination with other components to perform an immense variety of tasks. The power of 'micro-processors' is measured by the 'bits' of information individual 'chips' can process. The first handled 4 bits, the current ones 16 bits, and there are plans to realise 32 bit chips.

Other 'chips' have been developed with an ever expanding memory capacity. The first generation of these 'random access memories' (RAMs) could store 1k (1,000) bits of information. The current state of the art is 64k but more advanced (258k) devices are being made. These memory chips combined with micro-processors give the combined properties of a computer, hence micro-computers. The first true *micro-computer*, INTEL's 8048, is now being developed for more widespread use in the 1980s.

The thrust of present research and development is partly to extend the capacity of chips (ie to take miniaturisation even further) and partly to combine them in such a way as to perform different tasks.

APPENDIX 3: THE PAL LICENCE

The main transmission system operating in Western Europe is PAL (the Phased Alternating Line: PAL) as opposed to that in France and Eastern European countries (Sequential and Memory: SECAM) and the original system adopted in the USA and Japan (National Television System Committee: NTSC). The need to design products and established production facilities to suit each one of these technical requirements has acted as an artificial barrier to trade between countries operating the different systems mainly because of the with-holding of patents for the PAL transmission system. The PAL system was devised in 1961 and there are around 80 PAL patents affecting the design of television sets, 10 of which are regarded as major ones. Companies wishing to produce sets for markets in the PAL transmission systems are required to take out licences from the West German manufacturer Telefunken. Initially, Telefunken was unwilling to allow Japanese manufacturers to make any PAL sets at all but since 1970 11 Japanese companies have been licenced. The licences were granted on conditions which severely restricted non-local manufacturers and in the UK the operation of the licence by EMI) effectively prevented imports of sets above 20 inch. The use of the restraint against producers in the South East Asian NICs has been somewhat ambivalent. Korean firms have not been granted a licence and are excluded from the European market. Taiwanese firms have also had difficulties as the President of United Electronics (a Taiwanese firm) has pointed out, 'we talked to Telefunken - and found out that the company just doesn't want to release the patent to makers in Taiwan to avoid dumping on the European market ... /as a result/ our sales to European countries will remain small'. However, Philips' investment in a portable colour TV plant in Singapore was granted a PAL licence and more recently,

according to BREMA, two Hong Kong manufacturers have also been licenced. Whether these are special cases or whether the licence will be more wisely granted remains to be seen.

However, Telefunken's main licence expired in 1980 and the rest of the PAL patents begin to expire in 1983, which explains the UK industry's fear of having to face competition from Japan and the NICs in the next few years. There is, however, an important clause in PAL agreements which restricts licenced countries to exporting only 50% of total production; this would effectively limit export-orientated NICs with small home markets (eg Korea).

£2.50

ISBN 0 85003 076