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Economic Analysis, Public Policy and the Software Industry

by

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Abstract

This paper focuses on three related matters. It analyses the process of competition in the software industry, this being important both in itself and for the light it throws on competition within all industries characterised by low or zero marginal costs and a high rate of technical development. The software industry, operating under private enterprise, is dependent on copyright, and the issues raised by intellectual property protection are therefore also considered. Given the need for inter-operability between different software products, and between these and associated hardware, standardisation is important within the industry, and the processes by which standards may be established are evaluated. Consideration is given to the public policy issues that are raised by these three topics.

Keywords

Software, competition, innovation, standardisation, intellectual property protection

JEL classification

D23, L22, L63

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[1] St. John College, Oxford. Microsoft assisted me in the preparation of this paper with financial support, under its on-going programme to support academic research in the areas of information technology and public policy, and by enabling me to visit its headquarters in Redmond, U.S.A., where members of its staff helped me to acquire relevant factural information. The opinions expressed in the paper are my own. My thinking in the subject has been influenced partly be specialised academic literature on the software industry, but to a greater extent by ideas that I have developed (and written about) myself over the years. I have been influenced also by my previous experience as a Member of the U. K. Monopolies and Mergers Commission, as Economic Adviser to the U. K. Atomic Energy Authority and as Chief Executive of Oxford University Press.

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Part 1 The Economics of the Industry

Introductory

That the software industry is important need scarcely be argued; its product is integral to a vast and increasing number of activities which implement the new information technology and which are already changing, and will continue to change, in ways we can now only dimly foresee, innumerable aspects of our daily lives.[2] It is a strikingly novel industry, which displays a pace of technical development and of structural mutation that can have few, if any, historical parallels. The techniques of economic analysis inevitably lag, in their development, on the changing phenomena to which they are applied, and it would not be surprising for explanations and judgements relating to the software market to take less than full account of its special characteristics. This first part of my paper offers an economic analysis of the industry; the second part deals with the policy issues, including that of intellectual property protection, upon which the existence of the market for software crucially depends.

Costs and Competition

In order to understand the working of the software industry, four key features have to be borne in mind. These features are, the zero marginal cost of using technology, the rapid rate of innovation, the existence of networks, and the role of standards. It is of course the interaction of these several circumstances which ultimately have to be considered, but I shall begin by discussing them separately.

Although there may be costs in creating knowledge, they are independent of the extent to which the knowledge is subsequently used. The costs incurred in developing a software program in particular are unaffected by the extent to which its use is licensed. In that sense the marginal cost of using the software, the cost, that is to say, of granting additional licenses, is zero, or at any rate relatively small.[3] The production and distribution of diskettes, license documents and manuals will enter into the marginal costs of the supplier when they are part of the licensing transaction, but need not do so

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[2] The development of the software industry is the subject of many articles in periodicals and newspapers (such as the Economist and Financial Times) which I have found useful. Indirectly relevant is th very extensive literature of standardisation. The historical development of the industry is well dealt with by Langlois, R. N., "External Economies and Economic Progress; the case of the Microcomputer Industry", Business History Review 66 (1), pp. 1:50 (1992). Additional references that the reader may find illuminating are referred to in footnotes below; I should like to express my appreciation to Ms Kirsten Bindemann, who kindly compiled them.

[3] Smith, G. V. and R. L., Intellectual Property: Licensing and Joint Venture Profit Strategies, New York et al., John Wiley and Sons, pp. 156:7 (1993).

where installation by a computer manufacturer is concerned. User support costs may also be an element in the supplier's marginal costs, but development costs, which are independent of sales volume, are overwhelmingly predominant. Of course costs are incurred, indeed heavy costs, in *creating* additional demand for licenses, but not in *fulfilling* that demand.

We have to accept that, where the marginal cost of production is zero, we are posed, or seem to be posed, with a dilemma. On the one hand, it would appear to be in the interests of consumers that the available economies of scale are fully exploited, which, in the zero marginal cost case, would suggest that one producer should cater for the whole market. There would appear to be no room for a second supplier of a particular software product, far less a third or fourth, if the first supplier can meet any level of demand, however great, without any difference in the costs incurred. On the other hand, it is in the interests of consumers that the benefit from the full exploitation of scale economies should be passed on to them in the form of lower prices, which will not dependably happen unless suppliers are subject to competitive pressure. It is also in the interests of consumers that there should be, in the development of software, a variety of approach. We need therefore to consider whether, and how, these aparently conflicting requirements are reconciled in the market for software; how is it possible, in other words, to have the advantages which monopoly would here seem to offer, while at the same time having those which only competition can provide?

We have first to note the rather obvious circumstance that competing software products need not be identical, but may offer differing features. Each product can then find its own particular market among those to whom its particular features appeal, while at the same time, the presence in the general market of users who find the products reasonably good substitutes ensures price competition between them. In this way, as in many industries, economies of scale are balanced against the demand for variety, and competition maintained.

In the software industry, however, a further powerful factor is at work. Because of the high rate of underlying technical change, the life of a product is typically very short.[4] A firm may introduce a new product and drive hard, by means of its marketing policies, to achieve the large volume of sales that, where marginal costs are zero, makes it possible to have low prices and high returns. If successful, it may then enjoy the lion's share of a particular market. But, although it will have won a battle, it will not have won the war. Its competitors will already be planning to bring out a better competing product, and the firm itself, for the sake of its survival, will already be planning its own next move.

As we have already noted, a software product is subject to price competition through the existence

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[4] McClellan, S. T., The Coming Computer Shakeout, New York et al., John Wiley and Sons, (1984).

of alternatives, which, at least for many users, are good, even if not perfect substitutes. But much more deadly competition is continuously provided by the stream of new and improved products that take away the ground from under the feet of the established ones. No doubt it is true of most industries that firms have to run in order to stand still, but rarely do firms have to run so fast as in this one. We have only to consider how the landscape in computing changes in five years, far less ten, to appreciate how strongly the "gale of creative destruction" blows though this particular market.

One finds, in the software industry, competition which as well as being *concurrent*, is *sequential*, in the sense that a product may dominate in a particular market sector at one time, but is always liable to be replaced, after a short interval, perhaps two years, by another. In manufacturing industry, there is not the same liability to large and rapid changes in market share, because of the time needed to install productive capacity.[5] In the software market, there is no corresponding circumstance, with the result that market shares are potentially much more volatile. I say potentially, because producers will strive to keep what they have gained, appreciating that, in a market of this kind, no position is secure. The fact that shares may not in fact change violently is not evidence for protected markets; competitive pressures are exerted by the constant threat of displacement, which established firms can ward off only through rapid and successful innovation.

There are, of course, limits to the potential volatility; a new product does not sell automatically, but only with marketing effort, and users will show some reluctance to switch to a new product from another with which they have become familiar, and in the reputation of whose maker they have come to trust.[6] Leap-frogging is also not inevitable; a firm with a lead in a particular market will strive to maintain it through continuous upgrading of the product, its experience, acquired capabilities and market connections helping it to do so. Such advantages are enjoyed by established concerns in industry generally, and firms compete in endeavouring to secure and maintain them. But there is plenty of evidence that these advantages are not normally for long decisive; where the scope for innovation is particularly high, a fresh approach may often prove successful and past success and experience can trammel as well as support. Only myopia can lead one to believe that a commanding position is unassailably and continuously secure. We all know that the future will differ from the present, but it seems to require an effort of imagination fully to appreciate the fact. The established firm, however mighty it may seem, can be brought down, or at least for a time eclipsed, by complacency, by

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5 This idea is developed in ny own DRUID Working Paper no. 96-10, "Competition, Innovation and Increasing Returns", (July 1996).

6 Some of the practicalities involved in marketing computer software, given in particular the legal context, are discussed in detail in Davidson, D. M. and Davidson, J. A., Advanced Legal Systems for Buying and Selling Computers and Software, New York, John Wiley and Sons (1987).

arrogance, or simply by the fact hat market opportunities or technical possibilities change in a way that favours others with different mind-sets, more relevant experience, more appropriate market connections, or simply greater luck. This is true generally, but particularly so for an industry in which positions are so continuously challenged, and in which, as past experience shows, it is so difficult to know what the future holds in store.

We have to recognise that it is in the public interest, both that a successful product gains a large part of the market for products of that class, and, at the same time, that this tendency is neither unlimited or irreversible. Observation confirms that this is what happens; a product may gain the predominant share of a market, but is unlikely to gain all of it; older products will typically still be in place, new ones, having gained a foothold, will be striving to tip the general market their way, and other products will have found a niche market by offering special features.[7]

The fact that one software product tends, at any one time, to have the lion's share of a particular market, is the natural outcome of increasing returns to scale and other circumstances which we shall examine below; it provides, however, no prima facie case for presuming the existence of monopoly power, and of the detriments, such as protected inefficiency or high prices, commonly associated with the exercise of monopoly power. In the case of PC operating systems, for example, one product currently has a very large share of the market, but there are competing products, powerfully backed, seeking to displace it. And the issue is not so much which products will gain ground if circumstances remain the same, for we know that circumstances will change, and in such a way that the products competing tomorrow will not be those competing today. The past experience of the industry makes this clear; dedicated word processors for example, gave way to the general purpose personal computer, and character based application gave way to those that were graphically based.[8] And such paradigm shifts will certainly continue to take place in the future; the microprocessors for which the operating systems are designed are in continuous development, and computers of the future, such as PC telephones, PC -TV's and multimedia machines of whatever kinds, will be different from those of the present.

The firm winning the current race ought therefore to have its mind already on the race to come. That

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[7] The analysis presented on this paper derives in part from my own academic work on the process of competition. This is set out most fully in Richardson, G. B., “Information and Investment: a Study in the Working of the Competitive Economy”, Oxford, Clarendon Press, p. 67, p. 228. (1990).

[8] Dvorak, J., Dvorak Predicts: An Insider’s Look at the Computer Industry, Berkeley, California, McGraw - Hill (1994). This book deals with the current state of competition within the software industry rather than with the general principles that are here my concern.

firm's products are liable to lose ground, not gradually as in some industries, through the gradual erosion of profit margins as a consequence of rivals' cost savings and incremental improvements, but because a new need arises which a rival has the product to meet and it does not. Competition with this modus operandi is of course not new[9]; what is new, and features so markedly in the software industry, is the rate at which innovation takes place. Perhaps the best example of this is the growth of the Internet, particularly its World Wide Web, which doubles in size every few months. This growth has created new markets and has forced some companies substantially to change their business strategies. The fact that we cannot, in the nature of things, predict the changes that will radically transform the industry's landscape should not lead us to doubt that changes will come about; only ignorance of history, and poverty of imagination, would lead us to that conclusion. Nor should we be led to believe, when established firms do maintain their place, that the powerful influence of innovation has not been at work. Competition of the kind we are considering works as a discipline, and the threat of dislodgement being ever present. Those who doubt this phenomenon should take account of the fast development of the Internet which in the space of a few year has evolved from an obscure network serving a limited number of academic sites in a few countries into a global network connecting millions of individual computers.[10] The Internet as also begun to serve as a cheap, fast and international alternative to the physical distribution of software products through traditional retail outlets. Not only do these developments mark a dramatic paradigm shift for the existing software market, they have created a market for a range of entirely new software products, such as “Web browsers” for the Internet. Such an environment affords companies that are new or marginally important in today's software market the opportunity to capture a significant share of tomorrow's software business. Start-up companies such as Netscape, which has been remarkably successful with its Web browser, are thus on a strong footing in competing with more established companies. This constant transformation of the software industry's technological foundations provides a relentless challenge to the competitive position of every market participant.

Systems and Networks

I have so far analysed the working of the software market without attending to one of its most important features. A software product is of no use in itself, but only when working in conjunction with other complementary products as part of a system. Thus in the simplest case of an isolated

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9 idem.

10 According to a study by International Data Corp. at the end of 1995 there were between 8 and 10 million individual users of the World Wide Web. By the end of 1996 the number is expected to grow to 30 million. By the year 2000, that number man go as high as 200 million. Stets, D. “Computer Expert Warns of Internet Reaching Overload”, The Atlanta Journal and Constitution (14 Jan. 1996).

personal computer, software products must work with each other; an operating system, specifically, must work with applications, as well as with a microprocessor and other elements in a hardware platform. In the case of an extended network such as the so-called information highway, the set of related components will be much larger.[11] If these systems, large or small, are to do what we expect of them, then the component parts must be so designed as to inter-operate.

In what ways can this be achieved? One model would be for a whole set of related components to be made by a single firm able itself to assume responsibility for so designing them as to ensure the needed compatibility. This way of achieving a set of inter-operating components may be termed *planned integration.* But although some such integration does take place in the sphere of activity we are considering, it is manifestly not how the necessary coordination is in reality generally brought about. It is instructive, nevertheless, to ask ourselves why this is so, for, by identifying the disadvantages of planned integration, we shall be better able to understand the inherent economic logic of the alternative ways in which the market can bring into being the sets of inter-operating products which information technology has made available for our use.

Two circumstances set limits to what can be achieved by planned integration within one firm. The first arises from the fact that the different component elements in a set, such as, for example, microprocessors, monitors, disks and software, require, although they have to inter-operate, very different skills, experience, and equipment in their production.[12] They require, that is to say, a variety of capabilities not all of which are likely to be possessed by one firm. The second obstacle to planned integration is simply the economies of scale that feature in the production of some of the component parts of the set. A firm able to meet the development costs of, say, all the hardware components and associated software of a computer, would have to be very large indeed; there would be room, in any economy, for very few of them, and the barrier to entry would be exceedingly high. Consumers would be limited in their choice between the complete systems of different manufacturers and not be free to select between hardware and software components as they can in fact now.

The personal computer industry did not develop through the integration, by single manufacturers, of

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[11] A compendious survey of the law on computer software is provided by Kutten, L. J., Computer Software, Callaghan, Illinois, Clark Boardman (1995) and also in Scott, M. D., Scott on Computer Law (2nd edition), New Jersey, Prentice Hall Law and Business (1992).

[12] This point, crucial in this context, is developed more fully in an article which I wrote to identify the circumstances in which the coordination of economic activity can take place simply through market transactions between firms, as distinct from the circumstances in which it requires cooperative arrangements between firms and the circumstances in which it is best brought about by direction within a firm. Richardson, G. B., "The Organisation of Industry", Economic Journal, pp. 883:96 (Sept. 1992).

the related elements in a system.[13] A very large number of firms are engaged in making hardware and software components; there is some vertical integration, both IBM and Apple making both hardware and software, but within the computer industry there is a vast number of firms, of very differing size, linked in complex and changing patterns of competition and cooperation.[14] No doubt this diffuse structure owes something to historical accident, but the obstacles to extended integration noted above would, I believe, have led in any event to an industrial structure of the kind we now have.

That this structure has been favourable to the development and exploitation of information technology could scarcely be denied; certainly an historical parallel to the astonishing rate of growth of the personal computer industry would be hard to find. Economic analysis is not so reliably advanced that we can very confidently prescribe optimal industrial structures, and the more modest of its practitioners will be willing to accept the success of the prevailing, but unplanned, structure as creating a presumption in its favour.

How then, with many independent firms competing and cooperating in the market place, can the compatibility, or inter-operability, of their complementary products obtained? One obvious way is through the establishment of formal standards, agreement upon which may be sought through negotiation between the parties. The process is carried forward typically by small technical working groups seeking consensus, and, although governmental and inter-governmental agencies may be involved, private firms commonly provide the necessary personnel and finance.

Firms are prepared to work together in establishing compatibility standards when they perceive it to be in their interest to do so. And, where the demand for their products depends on inter-operability, a motive exists to achieve standardisation though agreement. But it is important to recognise that sometimes it is neither practicable, nor socially desirable for compatibility to be obtained by this route. There are two circumstances which, in this context, must be given weight.

First, there is the possibility of genuine uncertainty as to the best specifications to establish in order to define, and, when need be, re-define, a compatibility standard; this consideration is important in any industry subject to rapid technical change. In these circumstances, it may be better to put up with limited compatibility rather than fix standards before it has become clear how and when to do so.

Secondly, there are situations, of great importance in the industry which concerns us, where

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[13] On integration see also e.g. Porter, M. E., Competitive Strategy: Techniques for Industries and Competitors, London, New York, MacMillan Publ. (1980).

[14] See Porter, M. E., op. cit.

compatibility cannot be secured merely by choosing specifications, however careful and thorough the process may be, but has to be *created* at the cost of substantial investment and the application of technical and marketing skills. Compatibility is achieved this way through the mediation of a de facto standard, which in this context is the name given to a product which inter-operates very widely with others. It is to the adoption of these standards that we must now turn.

The creation of de facto standards

It is tempting to say that de facto standards, such as Novell's Netware or Microsoft's Windows, simply “emerge” in the market. But this is to make appear as automatic a development that is sought after through the application, over a period, of substantial resources. It is true that the market is the final arbiter, but the selection it comes to make is between alternatives, in the development, testing and marketing of which their firms have invested heavily. Windows is, in this respect, a good example. It is the product of extended technical development, but also of consultation with the makers of hardware and of applications software, and of elaborate, time - consuming and expensive programmes of testing, both by Microsoft and a host of independent individuals and concerns. The process of so-called “evangelization”, by which firms are persuaded to develop applications that will fit an operating system, is a crucial part of seeking to obtain the volume of derived demand that will tip the market in its fvour and make it a de facto standard. If all goes well, these efforts will lead to an effect of the snowballing kind I referred to earlier; hardware manufacturers will load the operating system because of the demand for applications that work with it and, as the installed base grows, so will the volume of related applications and the consequential derived demand for the operating system. If, however, momentum does not build up in this way, a great deal of money can be lost. The market provides the emerging standard with a pragmatic sanction; for those firms seeking to provide it, the risks are high and the prizes and penalties correspond.

In the working of industry as I have described it, there is every reason to expect operating systems that are de facto standards to be open, in the sense that the firm that created them will give freely the information about them that is needed by applications developers in order to make their products compatible. There is also every reason to expect that their use should be charged for. Without the prospect of an income from their licensing, the investment in their development, in the crucial process of evangelisation, and in subsequent user support programs, would not have been undertaken. Any argument that these systems should be costless cannot be sustained. The case for charging is the same as that made, in respect of all software designed to meet a market need, at the beginning of this paper.

Conclusions

If the analysis which is have presented is correct, the software industry is very competitive, and this despite the fact that particular products may enjoy large market shares. The most powerful force at work to preserve competition is the high rate of innovation prevailing; this ensures that no firm is invulnerable, but has to fight to maintain its position. Market shares are made potentially more insecure by the fact that the extent to which a product can be licensed is not limited by considerations of productive capacity. The public interest, it seems to me, is promoted by the resultant balance between competition, on the one hand, and, on the other, the exploitation of unlimited scale economies. The working of the market in this context does also produce de facto standards and, thereby, a substantial degree of inter-operability.

Questions arise as to the role, in this context, of legislation protecting intellectual property, as to whether competition could be made yet more effective by government action, and as to whether standards should be set in a manner different from that I have described. These are the matters to which I now turn.

Part II Public Policy

Introductory

In the first part of this paper, I sought to provide an economic analysis of the market for computer software; my aim in this part is to consider some public policy issues that arise in this context. I shall be concerned with the protection of intellectual property, with competition policy and with the establishment of industry standards, my hope being to help identify what should be on governmental agenda and what not.

The Rationale of Intellectual Property Protection

Software developers are paid for authorising the use of their products, and were this use not to require authorisation, unauthorised use being prohibited by law, they would have nothing to sell. The case for copyright protection, as normally put, is that it is necessary to provide an innovator with the incentive to undertake the investment, and bear the risks, of developing and marketing his product.[15] Without

[15] The Business Software Alliance (BSA) and the Software Publishers Association (SPA) state that the software industry loses approximately 50% of its potential profit to pirates. Cited in Dvorak, J., Dvorak Predicts: an Insider's Look at the Computer Industry, Berkeley, California, McGraw Hill, p. 4 (1994). See also Davidson,

a “closed period”, sufficient to enable the innovator, as the sole legally permitted seller of his product, to recover its cost and make a profit, the essential motivation would be lacking. But this way of putting the matter, although valid, fails to make clear that intellectual property protection is necessary irrespective of whether personal gain is the incentive to invest. It may give the impression that such protection would not be necessary if the investment were undertaken in a collectivist regime or by public authorities within a mixed economy.

Such a conclusion would be false. In any economic system with claims to rationality, a way must be found of assessing whether an investment is justified, whether the resultant benefits to society are greater than their opportunity costs; whether they are greater, that is to say, than the benefits that might have been obtained had the resources been put to another purpose. Where fundamental research is concerned, and the potential benefits uncertain, diffuse and deferred, assessment is very difficult, and the investment is, in the main, paid for by public bodies without a close calculation of return. The new knowledge produced may then be made available as a free good. That fundamental research is of great importance, not least in computer science, goes without saying, but there will be, in any kind of economy, a great deal of investment in the development of new products for which there is believed to be a specific need. And where investment of this kind is concerned, we have to find a way of making rational choices, of deciding whether and in what quantity resources should be applied to the development of this or that particular product for which there is believed to be a potential consumer demand.

The method of assessment generally used is, of course, that of comparing the monetary cost of the resources applied with what consumers would pay for the resultant product.[16] If the latter exceeds the former, then there a presumption that the investment was socially worth while. This test, although subject to qualification, is an essential starting point, but without intellectual property protection, it could not be applied. Unlicensed copying would prevent the relevant market prices from being established.

One might imagine that, in the absence of such protection, a public authority might somehow estimate how much they think that consumers would be prepared to pay for a software product which will in fact be made available to them free, and invest on the basis of that estimate. Such a procedure would however be, at best, exceedingly hazardous, for if the product were not in fact to be sold, there could be no way of finding out whether the estimates made were right or wrong. To further allocative

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D. M. and Davidson, J. A., Advanced Legal Systems for Buying and Selling Computers and Software.

[16] The basis of this propostion is to be found in the literature on efficient ressource allocation; see Richardson, G. B., Economic Theory, London, Hutchinson and Co., (1964) ch. 2.

efficiency, a system of prices has to be introduced, and a requirement for this, where we are concerned with technology that can be easily appropriated, is having patent and copyright protection in place.

A viable software industry, we must therefore firmly conclude, is quite crucially dependent on the effective copyright or patent protection. Only the very unreflecting would take the view that the creation of these legal rights, by the state, somehow dilutes competition within an industry; the reality is that these rights are a necessary condition for the very existence of a competitive industry in which resources are applied to create knowledge or information, from the licensed use of which it is hoped that revenue can be obtained.

Competition and Barriers to Entry

I sought to show, in the first part of this paper, that the computer software industry is highly competitive, despite the fact that one manufacturer's product may, for a time, enjoy the lion's share of its market. The rate of innovation was high enough to ensure, I maintained, that such a product would be continuously vulnerable to displacement. It has however been argued that, even if the possession of a large market share does not in itself afford the advantages of a monopoly, its existence within a set of complementary products necessarily does. This is the contention that I shall now consider.

Put simply, the argument runs as follows; even if a system superior to say, Windows, or Novell's NetWare, were to become available, consumers would be unwilling to switch to it, because of all the application software on the market designed to be compatible with the established products. In order to displace these products, a complete new set of complementary products would have to become available and offer such advantages as would justify the cost of switching to them. This inter-locking, it is suggested, constitutes a strong barrier to entry and provides the owners of the established systems with monopoly power.

There are a number of weaknesses in this argument. First, there is the simple point that a new product, say, an operating system, may be compatible with those applications designed for the established one.[17] Moreover, a new operating system would not have to be able to run every existing application in order to compete with an established one; provided its inherent merits were strong enough, the

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[17] This will, of course, not be a matter of pure chance. Any firm seeking to create a market for a new product has a very strong commercial incentive to offer such compatibility. Where compatibility fails to exist, moreover, the opportunity is created for specialist firms to develop, where feasible, software products which bridge the gap.

ability to run a sufficient number of important existing applications could carry the day.

If the new system were compatible with no existing application, then its acceptance would certainly be more difficult, but it would not be impossible. The firm introducing it would be obliged, as was the owner of the prevailing standard at an earlier stage, to induce independent software developers to write suitable applications or otherwise to do so itself. And where the life cycle of a product is as short as in this industry, entry on this basis is feasible.[18] So long as we analyse the possibilities of entry in terms of a static situation, the difficulties appear greater than in reality they are. The rate of innovation is such that the landscape is ever changing, with new opportunities continuously opening up. If established firms maintain their position, then they will have adapted their own products appropriately. No one can stand still.

As in every industry, being already established, or being first in the field, does offer advantages peculiar to that situation. If consumers are familiar with the product, if they are satisfied with it and with the support they have received, and if they know that it fits well with other products related to it in use, then they will display towards its vendor some limited loyalty. But the existence of reputations in the market place, and the position of a product within a network, provide no evidence of monopoly; it is, indeed, in the striving to gain, or defend, or challenge such positions

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[18] Porter, M. E., Competitive Strategy, Techniques for Industries and Competitors, London, New York, MacMillan Publ. (1980).

of advantage that competition characteristically manifests itself.[19]

We also need to reflect on the circumstances that, from society's point of view, justify new entry, or the displacement of one product by another. If a firm finds difficulty in selling, say, a new operating system, for the reason that it is incompatible with established and important applications software, then this is as it should be; there is a real cost to consumers and to society in having to replace existing application programs, and if that cost does not appear to consumers as likely to be compensated by the advantages of the new operating system, then this circumstance is in no way an unfair barrier to entry, but something that should properly enter into the calculations of a firm considering whether to offer the new system on the market.

For the reasons I have given, I do not think that a software program, which is a de facto standard linked to a network of complementary products, is thereby likely to have an unassailable market position. It may be maintained, however, that there at least exists the possibility that a software product, if it has become a standard, may become so strongly entrenched that undue profit is earned from licensing it. Competitors seeking to displace the standard have of course a motive for saying so, but, setting this aside, let us consider what the public policy response should be were the situation hypothesised be judged to exist.

It will not do to argue that such standards should be brought “into the public domain”; unless the public, through some official agency with appropriate capabilities, is prepared to meet the cost of maintaining and developing these standards, they will have to be privately owned. It would, of course, be possible to restrict the profits being earned on the product, either by curtailing the life of the associated intellectual property protection, or by controlling licensing charges. But whether such an approach would, on balance, further the public interest, is another matter. In an industry so fluid, where risks are great, where prospects of spectacular success are balanced by prospects of sudden massive failure, the notion of “undue profits” is difficult to define and to apply. The analogy with public utility regulation is scarcely close, as the industries concerned, compared with

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[19] The reputation, experience and connections of an established firm afford it a comparative advantage over potential entrants, but this does not constitute a barrier the existence of which is contrary to the public interest. Firms invest in the acquisition of these intangible assets in the expectation of deriving a return from them. All this should be very well known, and was dealt with at length by one of the greatest of economists, Alfred Marshall. See Marshall, Alfred; Principles of Economics, London, MacMillan, Chapter 11 (1890). It is interesting to reflect on his observation on p. 287 of this chapter, that “the very conditions of an industry which enable a new firm to attain quickly command over new economies of production, render that firm liable to be supplanted quickly by still younger firms with yet newer methods.”

the software industry, are strikingly sedate.[20]

The threat of leverage

Yet another detriment, or at any rate danger, is sometimes identified as a possible indirect consequence of the possession by an operating system, or other key program, of a large share of a particular market. A firm, it is pointed out, may be able to exploit a monopoly in one market in order to obtain a monopoly in another, a practice referred to sometimes as leverage. In the computer software industry, it has been suggested, a firm might use a monopoly in an operating system in order to oblige customers to license its own applications programs, which were compatible with that system, rather than those of competitors, which were not. No firm does in fact have a full monopoly in the market for operating systems, in the sense that computer users are obliged to buy its product. It may however be maintained that the possession of a large share of the market may be enough to permit a degree of leverage to be exerted. A firm might be able, it has been suggested, so to develop an operating system that certain applcations software programs, in competition with its own, will not work with this system. A weaker form of the accusation is that such a firm could seek, not wholly to disable applications software competing with its own, but merely to put such applications at a disadvantage by giving their potential developers less timely information about the interfaces with which they must be compatible.

Whether any particular firm does or does not behave in this way is first of all a matter of fact, and it is fair to start by noting that, although this behaviour has been alleged, regulatory investigation does not so far appear to have provided confirmation.[21] General reasoning, moreover, leads us not to be surprised at this outcome. We took note earlier of the importance, in establishing a de facto standard, of the process of "evangelization", and it is hard to believe that a firm, having invested heavily in inducing and assisting independent software vendors to develop applications for its operating system, would then seek to disable or disadvantage these applications. Of course it would be *possible* for the firm so to behave, but the breach of faith implicit in such behaviour could scarcely assist any future evangelising efforts. To the extent, moreover, that a firm were to limit the variety of competing

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[20] Recent activities of the European Telecommunications Standards Institute (ETSI) provide a dramatic illustration of the public difficulties presented by the appropriation of intellectual property rights through the standard setting process. In 1993, ETSI's general assembly approved an "Intellectual Property Rights Undertaking", which would have required members to license their patented technologies under "reasonable and non-discriminatory" conditions, if these were used to implement an ETSI technical standard, unless the rights owner objected within 180 days. A major confrontation ensued hat pitted various industrial sectors against one another and threatened a major trade dispute. In 1994, ETSI's membership overwhelmingly voted to annul the policy.

[21] Scott, M. D., Scott on Computer Law (2nd edition) New Jersey, Preentice Laaw and Business (1992).

applications with which its operating system would be compatible, the greater would be the vulnerability of that system to displacement by an alternative product.

Although it might be unwise for a firm to seek the kind of leverage in question, this does not prove that it would not do so. As economic analysis, in the nature of things, cannot rule out the possibility of such conduct, one cannot rule out the possible need for regulatory supervision. It seems to me wrong, however, to urge that the development of operating systems and application software should be disjoined, in order to exclude any possibility of abuse in question. The public interest could only suffer if a firm, having acquired a capability in the development and marketing of one kind of software, were prohibited from making the most of it through extending its range into another, particularly as the risks of displacement to which any particular product is exposed provides a cogent reason for some diversification. Forcibly to separate the development of the two related products would be to deny the public a benefit in order to claim to prevent an abuse for the existence of which there is no presumption and against which, in any case, there would be better remedies. It would be damaging, moreover, and rather absurd, to insist that, say, an operating system had to be compatible with a wide variety of applications, even where this necessarily involved depriving it of important advantages. Although it would be wrong to say that abuses in this area could never exist, I am inclined to think that the general interest will at present best be served, in the great majority of circumstances, by allowing the firm supplying a software product to determine the features affecting its compatibility on the basis of its own commercial interests.

Specifications and Standards

The emergence within the industry of software programs that have become de facto standards, which are proprietary, and for the licensed use of which users have to pay, is sometimes said to be against the public interest. Such key interfaces within the system, the argument runs, should be available to all without charge. Let specifications that ensure compatibility be laid down, it has been suggested, each developer of the interface software being then free to devise his own implementation of them. In this way, the argument continues, we can get the best of all worlds, achieving universal compatibility while maintaining competition between the different implementations.[22]

Within the context that concerns us here, this hope is illusory. An operating system, or its associated

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[22] For a presentation of the argument that there should be no intellectual properety protection for standard interfaces in the information society, see "Barrier Free Interfaces and the European Information Infrastructure", submitted to the European Committee for Interoperable Systems (ECIS) to the European Parliament hearing on the Global Information Society (Feb. 1995).

applications programs, is not to be compared with, let us say, the electrical plugs and sockets, for which compatibility can be secured by simple specifications. An elaborate process of consultation and development is needed to obtain widespread compatibility, and we know that, as new and improved versions of the standard are developed, the process has to be continuous. Who then would undertake and pay for the work of devising specifications, adherence to which is presumed to ensure compatibility and to which, say, all operating systems would have to conform? Who would undertake and pay for the periodic changes in the specifications that underlying technical changes, say in the microprocessor, would make necessary? How, and on whose authority, could the specifications be imposed? And if somehow adherence to the specifications could initially be obtained, what is to prevent developments in the various imlementations that would, in effect, start a drift from the standard? A developer might bring in a new product which met the specifications, and was therefore (let us assume) compatible with existing applications, but which offered functionality which made feasible new applications that would work with this particular implementation but none of the others. Is such a developer to be prevented from making this innovation? For what reason, and on what authority? These considerations lead one to believe that, while scope for agreed standardisation will certainly exist, some key interfaces will have to continue to be owned, and their use to be paid for.

Private Enterprise, the Information Highway and the Future

The progress made in software development owes much to fundamental work done by government agencies and in the universities. But it has also been furthered by the undertaking, by many firms large and small, of many speculative and risky investments, and, in consequence, by the spectacular success of some firms and the demise of many.[23] A variety of approaches have been followed, and competition has selected between them. In the nature of things, it would be difficult to mount, within the public sector of an economy, such a plurality of differing approaches, such a massive experimentation. If a government investment fails, the general public, or the party in opposition, is likely to attach blame and call for explanation; because of this, risky investments may be avoided, there being a natural reluctance simultaneously to adopt differing approaches, not all of which can prove successful. There is a good deal of evidence that the course of the development of the software and related industries has rarely been predicted correctly in the past, either by governments or by firms, and there is no reason to believe that future development will be any more predictable.[24] In these circumstances, there much to be said for an economic system that permits a good deal of trial and error, leaving it to the market to select the products, firms, and strategies that are successful.

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[23] McClellan, S. T., The Coming Computer Industry Shakeout, New York et al., John Wiley and Sons (1984).

[24] Which is not to say that predictions will not be made, e.g. those found in Dvorak, op. cit.

There is a further circumstance which favours private enterprise in this sphere of economic activity. The industry is characterised by much structural mutation; firms both compete and collaborate, they enter into changing alliances, sometimes across traditional industrial boundaries, they take other firms over, they lose staff who set up new firms, they flourish, and they fail. Such continuous re-structuring is the response called for by the pace of technical change and the need to relate activities which are complementary, with respect, say, to the development of an information highway, but which have been undertaken within previously distinct industries, such as communications, computers, publishing and television. And such permanent metamorphosis, particularly on an international scale, is a condition state enterprises are very much less likely to be able to manage.

As regards the future of the so-called information highway, it seems to me that, although we have a reasonably good general idea of the potentialities of inter-active systems of communication, no one can say with confidence exactly how they will be realised. Given this uncertainty, there is a strong case for a regime of commercial freedom. It is argued in a CEC White Paper (COM (93) 700 final, Brussels, 5 December 1993, p.66)[25] that we need "the establishment of a coherent and concerted approach to strategic alliances, the uncontrolled development of which could result in the creation of oligopolistic situations prejudicial to competition at world levels."[26] It is recommended that the effect of the alliances be assessed "simultaneously and in a concerted manner by the competent authorities."[27] One is bound to wonder, and worry, about what the authors had in mind. World wide alliances already exist, and will certainly further develop; they are essential to realise the potential of the information super-highway, which will require firms from different industries and in different countries to become engaged. There will also be competition between these alliances, and this competition (although no doubt intense) will be oligopolistic, for the reason that scale economies rule out the possibility of there being room for a large number of such groupings in the market place. In what way, and for what reason, are the so-called "competent authorities" to assess the alliances?

Perhaps the purpose of the assessment would be to decide which of the alliances were to receive public support and which were not. Or perhaps the authorities would endeavour to bring into existence groupings different from those that would have formed otherwise. It is in either case hard to envisage these aims being realised in any informed and rational manner; civil servants depend for information and opinion about the costs, technology and future prospects of particular industries very much upon what they are told by the firms within them, by people, that is with interests at stake. It

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25 "Growth, Competitiveness and Employment - The Challenges and Ways Forward into the 21st Century."

26 id. p. 66.

27 id.

is not possible to make strategic judgements, however, by reasoning from first principles, but only on the basis of limited and unreliable information and opinion of this kind. Even if it were possible in principle, therefore, for public authorities to determine an optimal pattern of alliances, and an optimal strategy for future developments in this area, they are unlikely in practice to be able to identify it. The realit is that no one knows for sure how the potentialities of inter-active communication will precisely be realised, and society in these circumstances is likely to be best served by there being some variety of approach, the resources being committed by firms that stand to lose or gain from the outcome.

I do not maintain that there is no role for government, or inter-governmental, action in this sphere. The very existence of the industry depends on a legal construction, copyright, which only governments can design and regulate. Nor do I wish to suggest that there will be no scope at any time or in any circumstances for governmental initiatives in setting standards. I believe, however, that governments should, in this matter, be pragmatic. Intervention can do more harm than good unless informed by an understanding of how free competitive enterprise operates in the software industry and an appreciation of the its essential appropriateness to the circumstances prevailing.

Danish **R**esearch **U**nit for **I**ndustrial **D**ynamics

The Research Programme

The DRUID-research programme is organised in 3 different research themes :

- The firm as a learning organisation

- Competence building and inter-firm dynamics

- The learning economy and the competitiveness of systems of innovation

In each of the three areas there is one strategic theoretical and one central empirical and policy oriented orientation.

Theme A: The firm as a learning organisation

The theoretical perspective confronts and combines the ressource-based view (Penrose, 1959) with recent approaches where the focus is on learning and the dynamic capabilities of the firm (Dosi, Teece and Winter, 1992). The aim of this theoretical work is to develop an analytical understanding of the firm as a learning organisation.

The empirical and policy issues relate to the nexus technology, productivity, organisational change and human ressources. More insight in the dynamic interplay between these factors at the level of the firm is crucial to understand international differences in performance at the macro level in terms of economic growth and employment.

Theme B: Competence building and inter-firm dynamics

The theoretical perspective relates to the dynamics of the inter-firm division of labour and the formation of network relationships between firms. An attempt will be made to develop evolutionary models with Schumpeterian innovations as the motor driving a Marshallian evolution of the division of labour.

The empirical and policy issues relate the formation of knowledge-intensive regional and sectoral networks of firms to competitiveness and structural change. Data on the structure of production will be combined with indicators of knowledge and learning. IO-matrixes which include flows of knowledge and new technologies will be developed and supplemented by data from case-studies and questionnaires.

Theme C: The learning economy and the competitiveness of systems of innovation.

The third theme aims at a stronger conceptual and theoretical base for new concepts such as 'systems of innovation' and 'the learning economy' and to link these concepts to the ecological dimension. The focus is on the interaction between institutional and technical change in a specified geographical space. An attempt will be made to synthesise theories of economic development emphasising the role of science based-sectors with those emphasising learning-by-producing and the growing knowledge-intensity of all economic activities.

The main empirical and policy issues are related to changes in the local dimensions of innovation and learning. What remains of the relative autonomy of national systems of innovation? Is there a tendency towards convergence or divergence in the specialisation in trade, production, innovation and in the knowledge base itself when we compare regions and nations?

The Ph.D.-programme

There are at present more than 10 Ph.D.-students working in close connection to the DRUID research programme. DRUID organises regularly specific Ph.D-activities such as workshops, seminars and courses, often in a co-operation with other Danish or international institutes. Also important is the role of DRUID as an environment which stimulates the Ph.D.-students to become creative and effective. This involves several elements:

- access to the international network in the form of visiting fellows and visits at the sister institutions
- participation in research projects
- access to supervision of theses
- access to databases

Each year DRUID welcomes a limited number of foreign Ph.D.-students who wants to work on subjects and project close to the core of the DRUID-research programme.

External projects

DRUID-members are involved in projects with external support. One major project which covers several of the elements of the research programme is DISKO; a comparative analysis of the Danish Innovation System; and there are several projects involving international co-operation within EU's 4th Framework Programme. DRUID is open to host other projects as far as they fall within its research profile. Special attention is given to the communication of research results from such projects to a wide set of social actors and policy makers.

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