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Law and Economics of Microsoft vs. U.S. Department of Justice: New Paradigm for Antitrust in Network Markets or Inefficient Lock-In of Antitrust Policy?

by

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LAW AND ECONOMICS OF MICROSOFT VS. U.S. DEPARTMENT OF JUSTICE

New Paradigm for Antitrust in Network Markets or Inefficient Lock-In of Antitrust Policy?

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Abstract

This paper contains an economic and legal analysis of the lawsuit Microsoft vs. U.S. Department of Justice beginning with the District Court's decision on June 7, 2000 up to the Proposed Final Judgement on November 6, 2001. I found that the courts' underlying economic paradigm regarding the assessment of monopoly power in 'New Economy Network Markets' was strongly influenced by BRIAN W. ARTHUR's theory of path dependence claiming (1) that high-technology markets being subject to network effects generally involve a danger of being locked-in to an inferior technology since winning or losing in a technology race is determined by small early random historical events and not by economic efficiency and (2) that there is almost no possibility to overcome inferior lock-in positions since network (compatibility) effects create insurmountable switching costs protecting the lock-in monopolist. As to Microsoft, it was often claimed that Macintosh would have been the better solution than Windows. The U.S. courts are convinced that rivals such as Linux wouldn't have any chance to overcome Microsoft's lock-in position without any antitrust intervention. However, I argue in accordance with opponents of ARTHUR's work that path dependence theory is only a theoretical curiosity that lacks empirical evidence. The predominance of a certain technology and especially the predominance of Windows in the operating system market is determined by economic efficiency and dominant market positions can be eroded very quickly by providing better quality. There is no empirical indication that network effects protect Microsoft's monopoly as it was claimed by the courts within their 'applications barrier to entry' theory. I claim that current interpretations of the U.S. antitrust law don't meet the requirements of fair competition rules in the 'New Economy'. If plaintiffs and the U.S. Department of Justice are victorious over Microsoft and lock-in theories become generally accepted by courts and market participants, further antitrust lawsuits are going to follow since most markets in the 'New Economy' are subject to network effects and high seller concentration. Strict antitrust policy could dampen economic growth due to investor uncertainty and the impossibility to take advantage of scale-based productivity effects.

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1. Introduction

After a long period of dealing with the U.S. Department of Justice, beginning on May 30, 1990, the lawsuit Microsoft vs. U.S. Department of justice reached a first peak on June 7, 2000 when District Court Judge THOMAS PENFIELD JACKSON concluded that Microsoft had abused its monopoly power in the operating system (OS) market and ordered a breakup of Microsoft into two companies, one with all the operating system software and one with all other products of the company.

The District Court's decision on June 7, 2000 has caused a very controversial discussion on antitrust policy in 'New Economy Network Markets'. Some economists are of the opinion that 'New Economy Network Markets' don't differ from 'Old Economy Network Markets', that is U.S. antitrust law and its current interpretation can be simply applied to new economy markets. However, the majority, including the U.S. Department of Justice is convinced that the Microsoft case raises new problems for antitrust due to demand side increasing returns to scale being called *network effects.*

If the utility a consumer derives from a network good increases with a growing number of other users using the same good, this good is said to be subject to positive network effects. For example, the utility of a Windows compatible computer is an increasing function of the size of the Windows user network due to compatibility with other Windows users. From a dynamic perspective, network effects are self-reinforcing leading to high seller concentration in the long run. A large installed base of Windows users in comparison with a small installed base of Macintosh/Linux users is going to cause *new* consumers to decide on the Windows system since (1) there is more application software available because software developers will write foremost for the operating system with the largest installed base and (2) the utility of being compatible with the huge Windows network is much higher than being compatible with the small Macintosh/Linux network. As a result, network effects make big things bigger (the Windows network) and small things smaller (the Macintosh/Linux network) leading to 'winner-take-all' and 'loser-gets-nothing' market solutions.

High seller concentration as such constitutes no problem for antitrust policy as long as the relevant market remains contestable by the absence of barriers to entry and/or barriers to exit. However, some economists and the U.S. courts are thoroughly convinced that network effects not only lead to monopolies but also *protect* the established monopolist from newcomers. As a result, network effect-based monopolies, and especially Microsoft's monopoly in the OS market, are considered as not being contestable at all in a dynamic perspective and therefore need strict antitrust intervention. The U.S. courts believe that even if there are newcomers providing much better quality than Microsoft, new OS technologies have no chance to overcome Microsoft's dominant position due to insurmountable *switching costs* which would have to be born by consumers since all Windows compatible software would become useless. As a result, there is no possibility to escape from the current inefficient Windows *lock-in* situation without antitrust intervention. Though the U.S. courts don't mention explicitly their theoretical background, empirical evidence of Microsoft's dominant and resistant market position given by the courts shows that the judgement was strongly influenced by BRIAN W. ARTHUR's theory of *path dependence*, a fact having often been neglected in the theoretical literature. The two core statements of path dependence theory are: (1) Markets being subject to large increasing returns to scale (network effects on the demand side and/or economies of scale on the supply side) generally tend to exhibit self-reinforcing mechanisms generating monopolistic lock-in market structures, (2) markets with increasing returns to scale generally involve a danger of being locked-in an *inferior* technology since winning or losing in a technology race is determined by *small early random historical events* and *not* by economic efficiency. As to the Microsoft case, it was often claimed explicitly in public debates that Macintosh would have been the better solution and that superior rivals such as Linux

wouldn't have any chance to overcome this inferior lock-in position. Against this background, the only way of restoring lost competition by destroying the self-reinforcing lock-in cycle would be a break up of Microsoft which was demanded by the District Court's ruling from June 7, 2000.

However, network effect-based lock-in theories are discussed very controversially in academics. Opponents don't deny the existence of increasing returns in the computer industry and the 'natural' evolution of high concentrated markets due to network effects, but they argue that high technology network markets *are generally contestable*, i.e. an incumbent can only dominate a market by above-average economic efficiency and is *not* protected from newcomers by network effects. Rapid technological change by a newcomer firm can destroy very quickly an established monopoly leading to a new monopoly of the newcomer. According to their view, competition in network markets can be best described as a SCHUMPETERIAN succession of temporary monopolies caused by creative (quality) destruction. Lock-in theory opponents maintain that Microsoft's dominant position is due to superior product quality and that a break up of Microsoft would result in a loss of social welfare. Their view is based on empirical studies claiming that ARTHUR's path dependence theory is only a theoretical curiosity that lacks empirical evidence. Further, advocates of the 'efficient competition view' argue that the District Court's interpretations of U.S. antitrust law and especially market definitions can't be applied to high-technology markets being subject to rapid technological change. In the light of their view, Microsoft can't be blamed for engaging in excessive aggressive and anti-competitive behaviour.

On the basis of the viewpoint that network effects and rapid technological change can offset each other, Microsoft appealed from the District Court's judgement on June 14, 2000. The Washington D.C. Court of Appeals ruled on June 28, 2001 on the appeal by Microsoft and found that some but not all of Microsoft's liability challenges had merit. The Appeals Court ordered that Microsoft mustn't be broken up into two parts though the court found that the company had repeatedly abused its monopoly power in the software business. The case was remanded to the District Court for a 'new' remedy determination. Still, the most striking point of the Appeals Court's decision is the fact, that the Appeals Court has agreed with the District Court that Microsoft can be considered as a lock-in monopoly being protected by network effects and that Microsoft's current dominant market position is simply the consequence of insurmountable switching cost and *not* a consequence of Microsoft's efficiency. From an economic perspective, the Appeals Court decision can be viewed as a contradiction in terms: According to the lock-in paradigm, only a break up could interrupt the self-reinforcing network effect cycle and restore lost competition like it was proposed by the District Court; however, if lock-in theories really were 'true', the decision to prohibit a breakup would have helped Microsoft to maintain its dominant market position.

On November 6, 2001 the Department of Justice and Microsoft proposed a settlement containing various conduct provisions. The United States and nine of the Federal States were able to reach agreement upon the so-called 'Proposed Final Judgement'. The remaining ten Federal States haven't joined the Proposed Final Judgement and are going to pursue the lawsuit to a full remedies trial. As a result, there is no clarity about the final outcome and about the ultimately remedy.

The Microsoft story has shown that there is a lot of uncertainty and contradiction concerning the assessment of demand-side and supply-side increasing returns to scale and their impact on long run market performance. Therefore, it is very important to check whether the hypothesis that network effects lead inevitably to inefficient and resistant lock-in monopolies is correct. If the thesis was true, antitrust policy would have to be very restrictive in order to prevent a 'natural tipping' towards a 'winner-take-all' and 'loser-gets-nothing' solution. Structural interventions as proposed by the District Court and theoretically supported by path dependence theory would be the appropriate solutions. The Appeals Court's decision

and the Proposed Final Judgement only containing conduct restrictions wouldn't end Microsoft's lock-in position and wouldn't improve social welfare. But if the thesis was incorrect and 'New Economy Network Markets' were really contestable, the District Court's and Appeals Court's underlying economic paradigm could cause a great damage on future economic growth. A lot of antitrust lawsuits driven by the 'loser-gets-nothing' fraction would not be far behind the Microsoft case claiming that antitrust policy should intervene in order to interrupt the self-reinforcing lock-in cycle since most new economy markets are characterized by dominant market positions of few firms. As a result, investor uncertainty would cause a drop of investment in high-productivity sectors due to uncertainty.

This paper tries to provide an answer to the question how antitrust policy should react to dominant market positions in network markets in general and in special, how to deal with Microsoft. This paper was originally written as a legal and economic analysis of the District Court's decision on June 7, 2000. Since the underlying economic paradigm regarding the assessment of monopoly power in high technology markets hasn't changed up to now, this version of the paper includes the complete original part and was extended by the Appeals Court's decision on June 28, 2001 and by the Proposed Final Judgement on November 6, 2001. Only a complete analysis of each judgement can provide the common grounds and the differences which couldn't have been shown in such detail if the text had been based only on the Appeals Court Decision and on the Proposed Final Judgement.

The paper is organised as follows. Part I contains the economic and legal analysis of the District Court's judgement on June 7, 2000. Chapter I presents a summary of the plaintiffs' arguments, the judgement against Microsoft and the court's legal and economic argumentation. Chapter II explains the court's underlying economic theory of path dependence. Chapter III contains a critical assessment of the Microsoft case with special emphasis on problems with path dependence theory and their implication for antitrust policy. Part II analyses the events beginning with the Appeals Court's decision on June 28, 2001. Chapter IV contains the investigation of the Appeals Court's decision and a comparison with the District Court's judgement. Chapter V deals with the Proposed Final Judgement and draws a conclusion on its impact on the future economic performance of the OS market.

PART I. ANALYSIS OF THE DISTRICT COURT'S DECISION ON JUNE 7, 2000

CHAPTER I. MICROSOFT AND THE U.S. ANTITRUST LAW

2. The Plaintiffs' Arguments

In May 1998, the U.S. Department of Justice and 19 Federal States filed suit against the Microsoft Corporation claiming a number of violations of antitrust law, especially violations of Section 1 and 2 of the Sherman Act[1]. Microsoft was mainly accused of:

(1) Monopolization of the market for OSs for Intel-compatible personal computers (PCs) by having taken anti-competitive actions to preserve and enhance its monopoly in the OS market (violation of Sec. 2 Sherman Act).

(2) Having attempted to monopolize the market for Internet browsers (violation of Sec. 2 Sherman Act) by anti-competitive bundling (integration) of the Microsoft Internet Explorer with the Windows OS (violation of Sec. 1 Sherman Act).

[1] The Sherman Act is one part of the U.S. antitrust law which is composed of several different Acts, for example the Clayton Act or the Federal Trade Commission Act.

(3) Having used anti-competitive contractual arrangements with original computer equipment manufacturers (OEMs) and Internet Service Providers (ISPs) in order to exclude Netscape's competing browser software Navigator from important distribution channels and to promote aggressively Microsoft Internet Explorer with the intention to preserve and enhance its monopoly in the OS-market (violation of Sec. 2 Sherman Act).

3. The Judgement

Judge THOMAS PENFIELD JACKSON ruled in accordance with the judge's findings of fact[2] on November 5, 1999, the conclusion of law on April 3, 2000 and issued his final ruling on June 7, 2000. The judge found Microsoft guilty in almost all counts preferred by the plaintiffs and ordered a breakup of Microsoft into two companies, one with all OS software and one with application software. Microsoft appealed from the District Court's decision on June 14, 2000.

The following three subsections will provide a review of the District Court's argumentation[3] and some additional background information about the U.S. antitrust law and its current interpretation. Special emphasis is laid on the District Court's economic point of view.

3.1 Accusation I: Microsoft Violated Section 2 of the Sherman Act Through A Course of Anticompetitive Conduct That Maintained Its Operating System Monopoly.

With the Sherman Act, enacted in 1890, the United States have been the first industrialized nation disposing of an antitrust law. The main objective has been to subject economic power to a democratic supervision. The principal policy instrument to deal with dominant market positions and the behaviour through which they are achieved, defended and also surrendered is *Section 2 of the Sherman Act* which reads as follows:

> *"Every person who shall monopolize, or attempt to monopolize, or combine or conspire with any other person or persons, to monopolize any part of the trade or commerce among the several states, or with foreign nations, shall be deemed guilty of a felony.(…)"*

According to current interpretation of the U.S. antitrust law, *monopolization* is illegal if the defendant engaged in wilful acquisition of monopoly power or maintained his monopoly by anticompetitive means in order to gain a competitive advantage or to hamper competition.[4] In order to establish the offence of monopolization of the OS market by Microsoft, plaintiffs have to prove that the following two facts are fulfilled:[5] (1) Microsoft has monopoly power in the OS market. A firm with monopoly power will find it profitable to charge a price significantly in excess of competitive levels[6] and maintain this behaviour over a significant period of time. This implies that there have to be substantial barriers to entry for newcomers enabling the incumbent to earn supra-normal profits. (2) Microsoft wilfully maintained or acquired its monopoly power by anticompetitive behaviour to gain a competitive advantage. This kind of behaviour is called 'exclusionary' or 'predatory'.

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[2] See JACKSON (1999), U.S. Department of Justice, Antitrust-Division , pp. 1-74.
[3] This text here refers to U.S. DEPARTMENT OF JUSTICE, ANTITRUST-DIVISION (2001a), pp. 1-150 presenting an excellent overview.
[4] See U.S. DEPARTMENT OF JUSTICE, ANTITRUST-DIVISION (2001a), p. 47.
[5] See U.S. DEPARTMENT OF JUSTICE, ANTITRUST-DIVISION (2001a), pp. 47-51.
[6] Usually, the competitive price level is defined as price equals marginal costs. However, this rule is very difficult to apply in software markets since information goods in general have marginal costs of zero.

3.1.1 Microsoft's Monopoly Power in the Relevant Market Protected by Increasing Returns to Scale and Lock-In[7]

The judge concluded that Microsoft enjoyed monopoly power in the market for Intel-compatible PC's allowing it to charge prices above the competitive level over a significant period of time without loosing market share to competitors. There are three factors indicating Microsoft's monopoly power: (1) Microsoft's large and stable market share, (2) the so-called 'applications barrier to entry' based on positive network effects on the demand side and economies of scale on the supply side protecting Microsoft's dominant market position and being responsible for no commercially viable alternatives to Windows and (3) Microsoft's pricing behaviour.

3.1.1.1 Microsoft's Market Share

Since the last decade Microsoft enjoyed a permanent market share of 90% in the market for OSs for Intel-compatible PCs. Even if one includes the Macintosh OS in the relevant market, Microsoft will hold a market share of about 80%.

3.1.1.2 The Applications Barrier To Entry Due to Increasing Returns to Scale

In general, if the principle *'bigger is better'* can be applied to some economic activity then this activity is said to exhibit *increasing returns to scale*. On the one hand, increasing returns can increase social welfare enormously but on the other hand, they constitute a special problem for antitrust policy since increasing returns to scale can lead to high seller concentration or even to monopolies which often result in economic inefficiencies. In the past, increasing returns to scale and high seller concentration stemmed mainly from economies of scale on the supply side. But the computer industry and especially software markets are additionally characterized by network effects on the demand side. Both factors combined, so the court's view as well, will result in monopolistic market structures much more susceptible to inefficiencies than conventional monopolies based on economies of scale.

Industrial organization theory states that monopolistic market structures can be a valuable and social desirable outcome because in case of the existence of increasing returns to scale competitive market structures can't generate the same economic welfare. However monopolies can only ensure a more efficient outcome as long as markets remain *contestable*, i.e. as long as the incumbent is forced to behave like a firm under competition. If a market is contestable, that means especially the absence of barriers to entry or barriers to exit, a monopolist won't be able to increase prices or to restrict output (allocative inefficiency) or to produce inefficiently (technical inefficiency) over a significant period a time; otherwise newcomers will enter the market and the incumbent would be forced out. On principle, potential competitors are able to ensure an efficient market outcome.[8] However if it wasn't possible to earn supra-normal profits for innovative firms as reward for their risk-taking and investments, a retardation of technological progress and a slow down in economic growth would be the inevitable outcome. As a result, market imperfections such as *temporary* barriers to entry are a necessary prerequisite for a *workable* or *effective* competition in the sense of SCHUMPETER, CLARK, ROBINSON, CHAMBERLIN and KANTZENBACH. Competition has to be viewed as a dynamic process which is characterized by phases of advances and pursuits. Pioneer profits due to temporary monopolistic positions are consequences and at the same time pre-conditions for workable competition. Supra-normal profits of innovative firms mustn't be used up instantaneously by competitors but have to disappear gradually, generating

[7] See JACKSON (1999), U.S. Department of Justice, Antitrust-Division, pp. 6-13.
[8] The theory of contestable markets goes back on BAUMOL, PANZAR AND WILLIG (1982).

sufficient incentives for new innovation. The speed with which supra-normal profits are used up by gradually emerging imitators or innovators can be viewed as the measure of intensity of competition. The general problem for antitrust policy in high concentrated markets is to assess whether there is effective competition respectively whether the relevant market is contestable or if the incumbent is engaged in anti-competitive conduct to acquire, preserve or enhance his monopoly.

In the Microsoft case, the court and some economic experts argue that economies of scale and network effects not only helped to gain a monopolistic position in the OS market but also constitute an barrier to entry for newcomers which can't be eroded in the next few years.[9] The market for OSs is considered as not being contestable. In addition to the lack of contestability, the court also blames Microsoft for having engaged in anti-competitive actions which have enhanced the barrier to entry as new technological possibilities were emerging being potentially able to erode Microsoft's dominant market position.

The court stated that the barrier to entry in the market for OSs, the so-called '*Applications Barrier to Entry'*, stemmed from the fact that application software written for example for Windows doesn't run on another OS like Macintosh. An OS is a special kind of software which controls the use of computer resources (the current most famous OSs for PCs are Windows, Linux, OS/2 and Apple Macintosh). But the main value a computer user derives from his computer comes from application software such as MS Word, MS Excel, Corel Draw, Lotus Notes, etc. The OS supports the functions of the application software by exposing interfaces, called 'application programming interfaces' (APIs). APIs are like synapses at which the applications software developer can link his software to the OS. For example, APIs are responsible for computer users being able to see e.g. a spreadsheet in Lotus 1-2-3 on the screen. Normally, different OSs provide different APIs to software application developers so that to make applications run on different OSs there are considerable expenditures to be undertaken because the application software has to be ported to each individual OS by additional programming.[10] However, due to supply side *static economies of scale* in software development, porting applications to other OSs is very unprofitable. Static economies of scale are defined as a negatively sloped long-run average total cost curve (LRATC).[11] Static economies of scale in software development originate from large fixed costs (R&D, investments in human capital) and from very low marginal costs (low copy costs). The production of the first output unit is very expensive but the subsequent units can be produced at very low marginal costs. Some economists argue that high-technology industries in general and software markets in special are subject to almost inexhaustible economies of scale leading to 'subadditive' cost structures or 'natural monopolies', i.e. a single company enjoying decreasing costs over the complete output range demanded. The dynamic competitive process will result 'naturally' in a monopoly since every competitor who doesn't produce the entire amount demanded by consumers, will be driven out by a rival who is able to produce more output and therefore enjoying lower costs. Only the firm producing the total output demanded can exist in the long run. A natural monopoly solution is socially desirable provided that the market remains contestable, since any output combination of more than one firm would lead to higher costs.[12]

[9] See for example FRANKLIN M. FISHER's direct testimony on the Microsoft case (2001), especially pp. 15-16.

[10] For example MS Word for Macintosh doesn't run on a PC with MS Windows. Therefore Microsoft created a special version of MS Word being able to run on PCs with MS Windows.

[11] By way of contrast, *dynamic* economies of scale are defined as a downward *shift* of the LRATC and can be interpreted as technological progress in form of process innovation or learning by doing effects. The difference between the two concepts and their implication on competition will be discussed later.

[12] However, natural monopolies are a standard case for antitrust intervention since in most cases markets being subject to subadditive cost structures aren't contestable any longer due to the fact that a considerable part of fixed investments are 'sunk costs', i.e. resources dedicated to one special use can't be used to another purpose. Sunk investments can lead to insurmountable barriers to entry for newcomers despite of inefficiencies by the

As a result, due to static economies of scale, application software developers seek to sell as many copies of their programme as possible – 'the bigger the better!' Moreover software developers wish to write for OSs that have a large number of users, especially for Windows because porting the application to another OS is very expensive. So if a new OS wants to become an important competitor in the current OS market for PCs it has to show a large *installed base* of users to be attractive for software developers. Consequently, economies of scale are responsible for monopolistic market structures in the application software industry and in the OS market due to subadditive cost structures. Thus, economies of scale can form a barrier to entry for newcomers in the application software and in the OS market whereas it is more difficult to overcome the barrier to entry in the OS market since a potential newcomer has to convince almost *all* existing application software developers to write for another OS which doesn't have such a large installed base as Windows.

However, it could be argued that a potential competitor would have a real chance to entice away enough consumers from Windows and to overcome the applications barrier to entry by showing a better quality in form of lower price or improved product quality than Windows. But switching to another supplier isn't so easy in software markets due to two kinds of *consumer lock-in* which stem from specific characteristics of software constituting very high *switching costs* for consumers. *First*, software is a durable good, i.e. software isn't subject to depreciation and therefore can be viewed as a form of sunk investment. For example, switching from Windows to Mac is very costly since all the software having been bought for Windows, all wisdom about using Windows and all Windows-compatible applications will suddenly become obsolete. *Second*, software products such as OSs or application software are so-called *network goods* which exhibit *positive network effects* or *increasing returns to scale on the demand side* depending on the size of a network.

In general, a network consists of (network) nodes which are connected through (network) links. These two elements always show a *complementary* relation to each other. For example, the provision of an Internet- or E-Mail-Service requires on the one hand hardware machines (nodes) and on the other hand telephone lines or Internet backbones (links) which connect communication partners. For a smooth functioning of a network links and nodes have to be *compatible*.[13] The utility a consumer derives from a network good can be divided in two components. The first component, the *autarky value* is the utility a consumer gets from the good even if there are no other users, i.e. if the network size is zero (a computer can be used without interconnection to other computer users). The second component, the *synchronization value* is the additional value derived from being able to interact with other users. This synchronization value is the essence of positive network effects.[14] The bigger the network the more valuable the network will be for the individual user because of (a) *direct positive network effects* which mean the possibility to interact with more other users (more communication partners who are Windows compatible) and (b) because of *indirect* or *market mediated positive network effects* which become evident for example in an improvement of network quality through the provision of additional services (e.g. communication with infrared interfaces in Windows 2000) or through a reduction in price caused by economies of scale due to an increasing installed base of Windows users. Therefore, switching from

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established monopolist since potential newcomers would have to provide at least the same capacity as the incumbent to realize sufficient economies of scale. But market entry would cause a doubling of supply and a decrease in price. The incumbent's profit maximizing reaction would result in a price decrease scanty above the variable (not sunk) costs despite losses, because leaving the market would mean a total loss of all fixed investments. Therefore, there would be no chance to earn normal profits. In anticipation of this result, a potential newcomer won't enter the market and sink fixed investments.

[13] In general, *compatibility* stands for the interchangeability of different systems (for example computer systems).

[14] See LIEBOWITZ & MARGOLIS (1994), pp. 133-150.

Windows to other incompatible OSs is becoming more and more unlikely with a growing market share of Windows due to increasing switching costs for Windows users.

A special kind of positive network effect is the establishment of *standards* or *common technical platforms*. Since compatibility is the crucial prerequisite for the functioning of a network, standards will be the inevitable outcome in network markets because the more common a standard is the more synchronization value can be derived from the network good. The establishment of an industry-wide standard can be achieved by different means. One possibility is the establishment by independent standardization bodies consisting of important suppliers and experts of the relevant markets. For example, in telecommunications the International Telecommunications Union (ITU) is responsible for the establishment of most international telecommunication standards. Major disadvantages of standardization bodies are their inertia in making decisions and their potential failure to set up an inferior standard because of lack of information. Another possibility of establishing standards is the so-called *de-facto-standardization* where different firms compete with incompatible standards for predominance in a market. This kind of standardization is very common in computer markets. There are no bodies coordinating the introduction of standards. Instead, consumer preferences, cost structures or initial gains in market shares will decide which company can win the technology race. Long run market structures with two or more firms having equal market shares are very unlikely since network effects favour monopolistic outcomes.

In the case of Microsoft, the fact of a large installed base of Windows users makes the product more attractive to other users. For example, exchanging files within a common platform is easier than converting each file for another OS. Further, it is much cheaper to buy a new Windows-based software than another OS-based software because everyone using already Windows knows how to use this software in principle – there are no additional training costs (e.g. in corporations). However, the main reason in the court's view for Microsoft's dominant position is the so-called *'chicken-and-egg-problem'*: Most consumers would probably choose this OS where most applications with high-quality are written for, where in all probability new versions of existing applications will be marketed and where new applications will be most expected. Consequently, software developers will write applications first and foremost for this OS enjoying the largest installed base (for image reasons and for economies of scale in the production). This large supply of applications as far it is concerned will reinforce the demand by consumers which again induces a wider range of applications and so on. This *self-reinforcing cycle* or *positive feedback loop* induced by network effects is also a kind of increasing returns – 'the bigger the better'. But the main problem, so the court's opinion, is that this virtuous cycle for Microsoft constitutes a vicious cycle for would-be competitors. There's no chance to break through this self-reinforcing cycle which makes big bigger and small smaller. *First*, consumers are locked-in the Windows OS since they would face high switching costs if they were changing their OS (fewer applications, unfitness of existing applications, learning costs, etc.). *Second*, and perhaps more important, a small or non-existent market share for newcomers would make it prohibitively expensive to develop a viable alternative to Windows because newcomers wouldn't be able to attract enough application developers writing exclusively for their OS. Even if there were application developers being willing to write applications for a new OS they wouldn't do so for a reasonable price. They would write first their application for Windows (economies of scale!) and then porting the application to the alternative OS but charging a higher price due to porting costs and the impossibility to exhaust the same economies of scale as with Windows. As a result, application software represents an invincible barrier to entry –'the applications barrier to entry'- to newcomers and enhances Microsoft's dominant position.

The court's point of view was underpinned by several empirical evidence. The judge argued that IBM had invested 10 billion US-$ in developing its OS/2 Warp OS for PCs which had been introduced in 1994. But IBM wasn't able to attract sufficient support by application

developers and gain market share. At the peak there were 2500 applications available for OS/2 and IBM enjoyed a market share of 10% but wasn't able to erode Microsoft's position. In 1996 IBM gave up competing with Windows. Today OS/2 is mainly used in banks for special applications. Another famous example is Apple Macintosh. For Mac systems there are roughly 12000 applications available but Mac isn't able to gain a relevant market share from Windows. A new competitor in the market is Linux, but Linux faces the same problems as OS/2 or Mac. Consequently, the court concluded that there were no commercially viable alternatives to Windows in the next few years as long as the applications barrier to entry remained strong (an opinion which is also shared by many OEMs) and that there was no chance even for a rival with superior product quality to compete effectively with Microsoft.

3.1.1.3 Microsoft's Pricing Behaviour

The court argued that there was substantial evidence that Microsoft had not considered other OS vendors as an essential constraint on its pricing of Windows. For example, Microsoft raised the price for Windows 95 for OEMs (the largest customers of Windows) to the same level as for Windows 98 just prior to the release of Windows 98, a behaviour which wouldn't be consistent with a competitive market. Normally, the price of an older version would stay the same or decrease but it was Microsoft's aim inducing OEMs to replace the older Windows version. Another indicator is the fact that Microsoft pursues price discrimination with OEMs. Companies which comply with Microsoft's wishes are charged lower prices (e.g. Compaq, Dell, Hewlett Packard) than corporations which do not (e.g. IBM and Gateway).

The judge stated that there was no possibility to calculate an exact short-run profit maximizing price and that there was no evidence of Microsoft charging the Cournot-price,[15] i.e. Microsoft did not maximize its short-run profits. Still, Microsoft is believed to maximize long-run profits. In a network industry a dominant firm's strategy can be to price low in order to enlarge the installed base to generate more network effects and thereby creating increased demand for complementary applications (MS Office) which provide an additional revenue source. Besides, a lower price is able to discourage software piracy and to enhance the applications barrier to entry.

3.1.2 Microsoft's Anti-Competitive Conduct[16]

An anti-competitive act is the use of means which restrict competition more than necessary. If this act is only profitable for the firm because of its restriction to competition and otherwise not, this act is called 'predatory'. Consequently, a predatory anti-competitive act is an act which is only expected to be profitable in the long run if this act is able to restrict competition. If this act is not able to stifle competition then there will be no profits for the firm committing the act. This definition includes actions which contain a deliberate sacrifice of profit in order to protect or enhance monopoly power.[17]

The court found that Microsoft had engaged in anti-competitive conduct mainly in order to protect its monopoly in the OS market by reinforcing the applications barrier to entry. The court argued that Microsoft's anti-competitive conduct had harmed the company's direct and indirect customers, had stifled innovation, and would not have been profitable or would have made business sense but for its effect of maintaining Microsoft's OS monopoly.

In the mid-1990s, Microsoft recognized that the dominant position of its OS was threatened by so-called 'middleware-software'. The most famous middleware technologies

[15] HALL & HALL (2000), pp. 188-191, concluded in their examination that Microsoft doesn't charge a monopoly price.
[16] See U.S. DEPARTMENT OF JUSTICE, ANTITRUST-DIVISION (2001a), pp. 11-39.
[17] See FISHER (2001), pp. 16-17.

Microsoft tried to combat against were Netscape's web browser 'Navigator' and Sun Microsystem's Java technology. In general, middleware software relies on APIs provided by the underlying OS while simultaneously exposing its own APIs to application developers, i.e. applications can be written *independent* of OSs. Applications only have to be compatible with the middleware software whereby the middleware software has to be compatible with the various underlying OS. For example, by making use of middleware software, it is possible to write a word processing software which is able to run on PCs and on Macs without any porting. As a result, software developers wouldn't have been any longer bound to Windows. There was a real chance that lots of applications would have been able to run on different OS. This technological innovation would have eroded Microsoft's applications barrier to entry and consequently its monopoly power. But Microsoft not only feared an erosion of its applications barrier to entry but also the possibility that Navigator and Sun would become full-featured OSs and therefore decided on combating Netscape and Sun. The main strategy was to compel OEMs by contractual arrangements to exclude Netscape's and Sun's middleware from the most important distribution channels Microsoft used in general. The next two subsections will present a short overview of the different anti-competitive actions Microsoft is blamed for.

3.1.2.1 Netscape

In 1994 Netscape had began on marketing its web browser Navigator. A few months later, Navigator became the dominant web browser. After having recognized Netscape's threat to Windows, Microsoft first tried to achieve an agreement with Netscape in 1995, a few months before Windows 95 was supposed to be released. If Netscape stopped developing Navigator as middleware (i.e. stop developing its own APIs for OS-independent applications) Microsoft would refrain from competing in the browser market. In addition, if Netscape didn't agree Microsoft wouldn't disclose the relevant APIs of Windows 95 for Navigator so that Netscape wouldn't be able to run Navigator on Windows 95. However, Netscape refused the proposal and was withheld technical information including the relevant Windows 95 APIs for a few months, though Microsoft routinely discloses the relevant application APIs to other application developers in time. Nevertheless, after a time lag, Navigator on Windows 95 became a success.

Microsoft knew that Navigator would only be a danger for its applications barrier to entry if it was able to become the dominant standard as a platform for OS-independent applications, i.e. only if it could generate sufficient network effects. Consequently, the next step to combat the middleware threat was to exclude Navigator from major distribution channels. OEMs being the most important customers of Microsoft usually pre-install OSs (usually Windows) and some application software on their computers. Thus, one strategy was excluding Navigator from the OEM distribution channel. At this time Internet Explorer hadn't been bundled with Windows yet but was sold as a separate product. First, Microsoft forced OEMs with contractual restrictions to take Internet Explorer with Windows and forbade them to remove or obscure it. Second, Microsoft imposed additional technical restrictions to increase the cost of promoting Navigator. Third, Microsoft offered valuable incentives to promote Internet Explorer to the exclusion of any other browser. Fourth, Microsoft threatened to penalize individual OEMs that insisted on pre-installing and promoting Navigator. Despite of these commitments, Microsoft believed that its contractual restrictions placed on OEMs wouldn't be sufficient to reverse Navigator's market share. Therefore, Microsoft decided to bundle Internet Explorer with Windows and unlike Windows 95, Windows 98 had no add/remove function for Internet Explorer, i.e. users had no chance to uninstall Internet Explorer. The strategy of bundling Internet Explorer and giving it away for free thereby deprived competitors to continue in or enter into the browser market. As a result, Netscape was forced to gave away its browser for free. In January 1998 only four of total 60 OEMs pre-

installed Navigator. However, Microsoft didn't succeed in monopolizing the browser market. In 2000, Navigator's market share had been still between 35% and 40%.

Microsoft also tried to foreclose Netscape from the Internet distribution channel by contractual arrangements with Internet Access Providers (IAPs). Microsoft engaged in giving IAPs substantial incentives to promote Internet Explorer instead of Navigator and was forced to sacrifice enormous revenues. For example, Microsoft created an folder for online services on its desktop and allowed American Online (AOL) to use this folder for its own placement for free. In exchange AOL committed to promote Internet Explorer. In addition AOL engaged in reducing the distribution of non-Microsoft browsers to no more than 15% of total AOL subscribers. Furthermore, AOL was prohibited to provide any link on its homepage to Netscape's Navigator. The campaign with AOL included huge renunciation of profit since the promotion of AOL on the Windows desktop undermined Microsoft's own Internet access service, the Microsoft Network (MSN), which was mainly created as a competitor to AOL and Microsoft had already invested hundreds of millions of dollars. Apart from AOL, Microsoft also engaged in similar contracts with AT&T, WorldNet, Prodigy and Compuserve.

Microsoft also compelled Apple Macintosh to exclude Navigator and to promote Internet Explorer by threatening to withhold the latest version of MS Office for Mac. Internet content providers and independent software vendors were also obligated in contracts to promote Internet Explorer instead of Netscape Navigator.

The overall consequence of Microsoft's campaign against Netscape resulted in a decline of Navigator's market share from 80% in 1996 to 35-40% in 2000. The court concluded that the campaign against Netscape was mainly to protect the applications barrier to entry rather than for any pro-competitive purpose. The faster growing installed base of Internet Explorer in comparison with Netscape's installed base which was growing as well but loosing market share, was not due to superior quality of Internet Explorer and lawful competitive wealth of ideas but due to predatory anti-competitive practices. The judge argued that Microsoft had harmed consumers by reducing the available choice of browsing software, by forcing to buy Internet Explorer with Windows, by imposing additional memory costs due to the supplementary installation of Netscape. Microsoft had also stifled innovation by excluding Navigator from the OEM channel because a free choice of pre-installing had made PC Windows systems easier to use and more attractive to consumers. Microsoft had also hampered the innovation process by Netscape who would have been able to supply a new platform for software developers. Netscape also had been forced to give its browser away for free and to use more inefficient distribution channels.

3.1.2.2 Java

Sun Microsystem's Java technology was also developed as an OS-independent application software platform with applications being able to be ported to different OSs without any substantial costs. Intel wishing to implement Java in cooperation with Netscape was threatened by Microsoft to be withhold Microsoft's support for Intel's next chip generation if Intel had supported Sun's efforts. In 1996, Microsoft bought a Java licence from Sun in order to develop a Windows compatible Java. The Windows compatible Java was designed to encourage software developers to write their Java application using special kinds of programming codes which only could be executed by the Windows compatible Java. One important advantage of Window's Java was its speed in comparison to Sun's Java. Because Window's Java was directly linked to the OS, it worked much faster than Sun's version which was not designed for a specific OS.

The court found that Microsoft took anti-competitive steps to discourage developers from creating Java applications. The aim was to create deliberate incompatibility with Sun's Java in order to protect the applications barrier to entry. Microsoft prevented consumers from

enjoying a wider variety of applications which would have been available with Sun's Java. The judge stated that Microsoft had stifled the innovation process by retarding and perhaps extinguishing the process by which the two middleware technologies could have facilitated the introduction of competition in the OS market for PCs.

3.2 Accusation II: Microsoft Violated Section 2 of the Sherman Act by Attempting to Monopolize the Browser Market[18]

Section 2 of the Sherman Act also states that the *attempt to monopolize* is illegal. In order to prove attempted monopolization plaintiffs have to show evidence that the defendant engaged in predatory or anti-competitive conduct with the intent to monopolize a certain market and that there was a dangerous probability that the defendant would succeed in gaining monopoly power.[19] Attempted monopolization includes bundling, price discrimination and exclusionary contracts if they have anti-competitive effects.[20]

The court found that Microsoft had unlawfully attempted to monopolize the browser market. The proposal to Netscape to stay out of the browser market in exchange for an end of further middleware development of Navigator would have caused a form of monopoly power since Microsoft would have been able to control the Windows compatible browser market with Netscape's dominant market position. The adjacent attempt to exclude Navigator from major distribution channels also had been an anti-competitive method of becoming dominant in a market characterized by network effects.

3.3 Accusation III: Microsoft violated Section 1 of the Sherman Act by Tying Internet Explorer to Windows[21]

Section 1 of the Sherman Act prohibits every vertical or horizontal restraints of trade or commerce. Section 1 reads as follows:

> *"Every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce among the several States, or with foreign nations, is declared to be illegal."*

This language is interpreted as making illegal *per se* all arrangements between competitors fixing prices, restricting or pooling output, engaging in predatory bundling or tying. In order to find out whether Microsoft can be blamed for tying its Internet Explorer, one has to constitute that Windows and Internet Explorer can be considered as separate products, otherwise there is no tying Microsoft can be blamed for. The court found that OS and browser were different products because early versions of Internet Explorer (1.0 and 2.0) were sold independent from the OS and there was no technological linkage. In all subsequent versions of Windows which included Internet Explorer, OS and browser were also considered as separate products since Microsoft would have been able to produce a Windows version by adding an add/remove function without any loss of efficiency. The court concluded that tying the browser had harmed consumers by reducing their choice and had stifled the innovation process. However, the court rejected the plaintiffs' claim that Microsoft's exclusive contracts violated Section 1 of the Sherman Act and decided that they were part of the Section 2 violation.

[18] See U.S. DEPARTMENT OF JUSTICE, ANTITRUST-DIVISION (2001a), pp. 87-97.
[19] See SCHERER & ROSS (1990), p. 469.
[20] See ECONOMIDES (2001), p. 3.
[21] See U.S. DEPARTMENT OF JUSTICE, ANTITRUST-DIVISION (2001a), pp. 97-107.

4. The Remedy: 'AppsCo' and 'Opsco'[22]

Generally, remedies in connection with violations of the Sherman Act have to do justice to three objectives: (1) Remedies must end an unlawful conduct, (2) remedies have to prevent recurrence of an unlawful conduct, and (3) remedies have to undo anti-competitive consequences of the unlawful conduct. In order to guarantee these objectives, the proposed remedy by the District Court contained two parts: (1) The structural part planned on changing the OS market structure by breaking up Microsoft in two independent companies, (2) conduct restrictions were to guarantee workable competition in the meantime until restructuring of Microsoft would have been brought to an end.

According to the 'structure–conduct-performance' paradigm (Harvard School), market structure influences market conduct and market conduct influences economic performance. Therefore, good economic performance (optimal social surplus) can be achieved by appropriate market structures. As a consequence, the *structural part* of the remedy planned on breaking up Microsoft in two independent companies. The OS part with Windows 95, 98, 2000, NT, CE would have been transferred to 'OpsCo' which would have also owned a permanent licence of Internet Explorer. The rest of Microsoft's business – the applications part - including MS Office, developer tools business and Internet Explorer would have be owned by 'AppsCo'. The court argued that the divestiture preserved the existing structure of the company's business units but fundamentally altered the incentives concerning the market conduct of both companies resulting in improved market performance by restoring lost competitive conditions. The judge claimed that the new market structure was able to select the most efficient technology by guaranteeing a market without substantial barriers to entry – a contestable market. The separation was able to limit the applications barrier to entry since Microsoft couldn't any longer use its applications as leverage in the OS market. For example, Mac was threatened by withholding the latest MS Office version for Mac in order to protect the OS monopoly by denying Netscape access to the Mac platform. In addition, 'AppsCo' had also incentives to sell its applications not only to Windows but also to other OSs like Linux thereby earning additional revenues. Further, 'AppsCo' would experience incentives to develop new products which could be made available to other OSs. The court also though that 'AppsCo' would have incentives to develop its own middleware by using Internet Explorer as the middleware software which is compatible with a lot of OSs and exposing APIs for new applications. Due to its high market penetration, Internet Explorer would possess the 'critical mass', i.e. generating sufficient network effects in order to induce software developers writing programmes for Internet Explorer middleware.

Since the break up of Microsoft would have taken at least a few years, *conduct restrictions* were meant to ensure effective competition in the OS market until restructuring would have been completed. Some restrictions would have ended with the break up and other restrictions would have lasted three years from the moment of completed break up. These conduct restrictions were designed to prevent Microsoft from exclusionary conduct in the period before the break up and to guarantee that 'OpsCo' would not engage in the same exclusionary conduct as Microsoft did. The main conduct restrictions were: (1) Microsoft was obliged to announce to *all* independent software developers (ISVs) information necessary to facilitate their software with Windows. In the past Microsoft withheld necessary information from ISVs who wrote applications for competing OSs such as Mac or Linux. (2) Microsoft was forbidden to include any middleware software within its OS unless this software would have had an add/remove feature. In this way, Microsoft should be prevented from abusing its applications barrier to entry to become the dominant middleware software. (3) Any contract restricting OEMs from excluding Navigator was void. (4) Microsoft was prohibited from

[22] See U.S. DEPARTMENT OF JUSTICE, ANTITRUST-DIVISION (2001a), pp. 119-145.

restricting OEMs from configuring Windows to launch automatically any non-Microsoft middleware, OS or application. (5) Microsoft wasn't allowed to engage in contracts forcing OEMs and end users of Windows to buy additional software in order to obtain Windows.

CHAPTER II. THE ECONOMICS OF MICROSOFT

5. The Court's Economic Viewpoint –Arthurnomics'

5.1 Lock-In and Long-Run Contestability

According to the District Court's view, Microsoft is considered to be a resistant monopoly. Network effects and economies of scale have been responsible for the evolution of the dominant market position, a problem well-known in antitrust policy. The crux with Microsoft so the court's view is the fact that network effects form an invincible barrier to entry for newcomers due to prohibitive switching costs for consumers who are thought of being locked-in to Windows. In the court's estimation middleware software *might* eventually weaken the applications barrier to entry resulting in viable alternatives to Windows. But the court also found that it was not sure whether software developers were willing to build up the same amount of applications being compatible with APIs of middleware software as with Windows due to the applications barrier to entry. And even if a development towards middleware applications would start or if it actually already had started it would take several years to erode the applications barrier to entry and offering a viable alternative to Windows.[23] As a result, the court believed that Microsoft's monopoly wouldn't be contestable in the *next few years* and also concluded that it wasn't sure whether the OS market was contestable *in the long run at all*.

The alleged effectiveness of the applications barrier to entry was supported by empirical evidence. The court stated that for example OS/2 hadn't been able to compete effectively with Microsoft though IBM had invested hundreds of millions of dollars. This view implies that OS/2 was thought to be of the same or even of better quality than Windows but had no chance to overcome the lock-in effect. Though the court *didn't mention any quality aspects* the argumentation reveals that quality must play a significant role in addition to the switching cost argument because how should any new OS be able to compete effectively without being better than the incumbent? It is supposed by information technology market participants that newcomers would have to provide a product at least ten times better than the incumbent to overcome consumer lock-in.[24] The OS/2 example shows that network effects are considered as being a protection shield and that it is not possible to overcome an *already existent lock-in position* by providing better quality than an incumbent.[25]

The court also argued that Apple Macintosh hadn't been able to compete effectively with Microsoft due to the applications barrier to entry. Thus, also Mac is considered showing reasonable or better quality for consumers than Windows. But there is one important

[23] See JACKSON (1999), U.S. Department of Justice, Antitrust-Division, pp. 10-11.
[24] See SHAPIRO & VARIAN (1999), p. 196.
[25] Originally, Microsoft and IBM *together* planed OS/2 as a completely new OS. OS/2 was designed to be a full 32-bit multitasking OS that would have a graphical user interface and would also be able to run old DOS programmes. Windows was supposed to be only an *intermediate* step. The first two versions of Windows (1.0 and 2.0) weren't able to supersede the command-line DOS-OS due to lacking quality. Only when Windows 3.0 was introduced in 1987, command-line DOS was replaced very rapidly. Nevertheless, in 1988, OS/2 was still thought to be the next generation of OSs. Therefore, 50% of all word processing applications were developed for OS/2 and only 10% for Windows 3.0. But as OS/2 was introduced in 1994 by IBM, Microsoft had already a gained a dominant market position in the OS market that couldn't be overcome by IBM. See LIEBOWITZ & MARGOLIS (1999), pp. 143-146.

difference between the OS/2 example and Mac: Microsoft and Mac entered both the software market at the beginning of the 1980s. So no firm had a lead in market share and there was no applications barrier to entry to overcome at the beginning. But Microsoft could gain permanently market share with its early command-line DOS in comparison to Apple who was loosing market share despite the fact that Mac was equipped with a graphical user interface and so would have been preferred by consumers.[26] But if Mac was and perhaps is still believed to provide the same or even better quality than Windows how could Microsoft dominate the market? With both firms providing the same quality from the beginning in the 1980s, one would expect a market outcome with roughly equal market shares. With Apple providing better quality than Microsoft, one would expect Mac dominating the market for OSs. Could it be possible that we're all not only locked-in to a monopoly which harms consumers by anti-competitive behaviour but also locked-in to an *inferior* technology in comparison to its early competitors? *The court avoided any statement within the judgement on this point.* However, the concern of being locked-in to an inferior 'Windows ' technology was expressed very often in the course of the proceedings. Newspaper accounts and experts often claimed that Mac would have been the better choice and that Windows had reached its dominant position simply by *chance*. Within the lawsuit against Microsoft, the reproach for being an inferior monopoly was highlighted by GERY REBACK, a lawyer working for several of Microsoft's competitors (including Sun and Netscape). In his white paper which was motivated by the striven acquisition of Intuit by Microsoft, REBACK demanded a break up of Microsoft in a lot of "Baby Bills" to end Microsoft's anticompetitive behaviour and to come to an end with an inferior standard.

All the arguments claiming Microsoft to be an inferior technology having reached its dominant market position simply by chance have theoretical support. The idea that markets subject to increasing returns to scale *can – not must!* – lead to inferior lock-in monopolies goes back on BRIAN W. ARTHUR'S theory of '*path dependence'*. Path dependence theory – 'Arthurnomics'- not only influenced lawyers, experts and newspapers but also the antitrust division itself. JOEL KLEIN – Assistant Attorney General, and head of the antitrust division from March 1998 until 2000 – singled ARTHUR out as a theorist who has particularly influenced his thinking on high-technology markets.[27] Thus, even if the court hasn't mentioned the fear of being lock-in to an inferior standard, the empirical evidence given by the court implies that ARTHUR'S thinking has heavily influenced the ruling by the court.

5.2 The Concept of Path Dependence: History and Early Chance Matter

The concept of path dependence and the possibility of dynamic market failure, i.e. the possibility of free markets not leading to technological optimal results under social welfare considerations, can be best explained with an example cited by ARTHUR himself of de-facto-standardization: the battle of the predominance in the videorecorder market in the 1980s between the two competing and incompatible standards VHS developed by JVC / Matsushita and Betamax developed by Sony. ARTHUR states that both systems entered the market at about the same time therefore enjoying initially roughly the same market shares and were sold at about the same price. Each system was subject to substantial demand side network effects, i.e. increasing returns to scale, since for example a large number of Betamax videorecorders induced owners of video-tape libraries to expand their supply of Betamax-compatible videotapes and this enlargement of Betamax tapes induced potential buyers of videorecorders to buy a Betamax machine since consumers orientated their buying decision according to the available amount of videofilms and the possibility to exchange videotapes with other users. Thus *each* system was subject to increasing returns to scale or positive feedback. This

[26] This kind of battle was a typical example of de-facto-standardization.
[27] See GATES (1999), p. 1.

example shows that markets subject to increasing returns to scale lead to the evolution of one single standard in the long run. A situation with equal market shares is an *unstable equilibrium*. In the end, VHS won the technology race and Betamax was driven out of the market. But like in the Microsoft/Macintosh example, it was often claimed that Betamax would have been the better choice. If the hypothesis that network markets can lead to a dynamic technology failure is right, then, which market forces were responsible for driving consumer decisions to the inferior VHS standard and not to the superior Betamax standard? In which way is one certain allocation outcome 'selected' when there are multiple possible long-run outcomes?

Conventional economic theory argues that economic efficiency, i.e. price and quality mechanisms are responsible for the determination of the market outcome. But conventional economic theory is also built on the assumption of *negative feedback* or *decreasing returns to scale*. Consider markets for generating electronic power: there are several possibilities e.g. oil, gas and water. But each possibility is subject to increasing costs. If electricity generation by oil was expanded, e.g. due to rising oil prices on the world markets, oil-producing companies would have to fall back on oil wells which would be more difficult to exploit than the existing oil fields because each expansion of production *under decreasing returns* runs according to the principle: first, take the resource with the highest return (here oil wells easiest to exploit) and then continue with the resource yielding the second highest return, and so on. This kind of expansion will continue as long as oil-production is cheaper than gas and water. But because of increasing costs in production and an decreasing oil price on world markets due to an increasing supply, there is a *'reflection point'* or a *'natural (cost) barrier'* which prevents the energy market from *'tipping'* completely into oil production since gas and water will become relatively cheaper than oil from a certain output point on. Thus, in markets subject to decreasing returns to scale market structures with all technologies having equal market shares or market shares corresponding to their cost structure is *a stable equilibrium* and *the only equilibrium* that can be achieved by the price mechanism. As a result, in negative feedback markets there is no selection problem of which technology will be dominating the market; the selection problem is reduced to the question which technology will have which market share according to its cost structure in comparison with other technologies.

ARTHUR argues that the selection problem in positive feedback markets is simply solved by *chance* or by *a first mover advantage* and *not* by economic efficiency considerations. In the videorecorder example according to ARTHUR, both formats started out with *equal* market shares and therefore were generating the *same* amount of network effects to consumers. Consequently consumers were indifferent between the two formats. Which format was bought next was simply left to chance or external circumstances. But if one format could gain a market share more than 50% simply by luck then consumers weren't indifferent any longer since the format with the larger market share created more positive network effects. So if one format enjoys only a little advantage the *probability* that this format will be taken next increases, i.e. the probability of buying VHS will increase with VHS' market share making the advantage of VHS larger and larger and at the same time making the disadvantage of Betamax larger and larger. But if Betamax had been inspired from luck and had been able to gain an early lead, VHS would have lost the game. Consequently, there *doesn't exist any reflecting barrier* which could turn back this self reinforcing cycle and stabilize the market shares with equal proportions. Instead, there exist *absorbing barriers* attracting this technology which has got an early gain in market share due to chance. The market will end up with one format dominating the market; consumers will be locked-in to a single standard and won't be able to leave this monopoly solution easily due to network effects and high switching costs. Network effects protect the incumbent against newcomers and form a barrier to entry (see the applications barrier to entry in the court's argumentation). However, which format will succeed is dependent on *early* 'accidents' or *early* 'chance' in the *historical*

development of the market, i.e. the outcome is determined by the *early adopted historical path*; therefore this process can be viewed as *path dependent*.

The idea of first mover advantages and early lucky circumstances determining the allocative outcome is not as new as could be expected. Even ALFRED MARSHALL stated that in markets with substantial supply side economies of scale (natural monopoly), the firm having moved first into the market and already having gained a substantial market share could corner the market without its rivals being able to enter the market at all. ARTHUR points out that MARSHALL supposed supply side increasing returns to scale especially in manufacturing industries because of their large plant size and large fixed costs. But reality has shown that supply side economies of scale are exhaustible in manufacturing and that the typical industry cost curve is dish-shaped. SHEPERD states that

> *"…the typical industry cost curve for the firm ... is dish-shaped, with MES*[28] *at 5 percent of the market or less. The constant-cost range may be wide, though presumably average cost rises eventually because of (1) bureaucracy, from absolute size; and / or (2) X-inefficiency,*[29] *caused by the firm's market power. The constant costs may also mask a significant amount of pecuniary*[30] *gains. If one filters out the pecuniary economies, the typical cost curve may slope upward instead of being flat."*[31]

SCHERER & ROSS also argue that

> *"…the long-run cost curves in most industries are much less steep at suboptimal plant scales than one is led to believe by the typical textbook illustration."*[32]

The result of exhaustible supply side economies of scale in manufacturing is that a lot of industries are characterised by oligopolies in reality, e.g. automobile industry, steel industry, etc. But there are also industrial sectors where there are no significant economies of scale, e.g. in cement production or beer brewery where transportation costs limit marketing areas on a regional plain.

However, ARTHUR argues that all knowledge-based sectors in the economy (computer industry, aircraft industry, pharmaceutical industry) would be subject to huge static economies of scale and therefore to positive feedback with the bias towards monopoly lock-in outcomes due to large fixed costs (R&D, plant size costs) and tiny marginal costs. Furthermore, learning by doing effects in production of high-tech products can lead to positive feedback as well. But learning by doing effects by consumers are important, too: the more a consumer uses Microsoft Word, the more efficient he can work with and the more switching costs would have to be borne. Summing up, according to ARTHUR there are three possible forces causing positive feedback and lock-in: (1) Static economies of scale on the supply side, (2) demand side network effects with consumers and (3) learning effects on the supply and on the demand side.

The main disadvantage with path dependent processes is the fact that there is no mechanism guaranteeing efficient outcomes. In table 1, there are two different technologies A and B, both generating growing positive network effects with increasing adoption by consumers *but at different rates*. Consumers are assumed to be homogenous, thus there is no

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[28] MES stands for *minimum efficient scale* indicating the smallest output scale at which minimum unit costs are attained.

[29] The concept of X-Inefficiency goes back on HARVEY LEIBENSTEIN and is defined as the non-allocative inefficiency of a company which is caused by a lack of competition. The consequences of missing competition are lacking motivation of the management and the staff.

[30] Strictly redistributive savings due to economic power benefiting larger companies are defined as *pecuniary economies* in contrast to real economies (of scale) resulting when resources are actually saved. For example, pecuniary economies can be realized when large firms are able to extract volume discounts from input suppliers being not associated with any real savings gained by supplying in larger quantities.

[31] See SHEPERD (1990), p. 234.

[32] See SCHERER & ROSS (1990), p. 114.

natural preference for a certain system; adoption decisions are made only by actual payoffs. Let us assume that technology A (e.g. the VHS format) is able to generate more utility at the beginning (e.g. video tape library have decided *arbitrarily* to have more VHS tapes in store than Betamax tapes). The first adopter would expect a payoff of 10 if he chooses technology A (VHS) and a payoff of 4 if he chooses technology B (Betamax), thus he will choose A. The second adopter would also choose technology A and so on. Technology B (Betamax) doesn't have any chance to get started. Because of an early coincidence technology B (Betamax) will end with a market share of 0% and technology A (VHS) will enjoy a market share of 100%. But after 30 choices technology B (Betamax) would have generated the same utility as technology A and if the number of adopters had become larger than 30 technology B would have been the better choice (e.g. because Betamax had a better picture quality). In the end the market will be locked-in to an inferior technology. Such a process is called *path inefficient*. There's no possibility of *'locking out'* because nobody would like to be the first adopter of technology B which would only generate a payoff of 4 in comparison with a payoff of 20 with technology A. So this is a typical situation of a *'prisoner's dilemma'*: all consumers would be better off if they were able to coordinate their actions to switch all to technology B but since there's no coordination mechanism, nobody wants to lock-out of the solution because the first mover can't rely on the remaining 99 consumers to switch as well. As a result, each consumer will stay with technology A. If technology B had been inspired by chance, then the outcome would have been *path efficient*. In reality, it was often claimed that Betamax would have been the technically superior solution in comparison to VHS. One can find the same argumentation with Windows vs. Mac.

Adoptions	0	10	20	30	40	50	60	70	80	90	100
Technology A	10	11	12	13	14	15	16	17	18	19	20
Technology B	4	7	10	13	16	19	22	25	28	31	34

Table 1: Payoff Functions with Increasing Returns to Scale. Source: ARTHUR (1997b), p. 19.

Summing up, in markets subject to increasing returns there exist *multiple equilibria*. In the case of a two-technology-market there is one equilibrium with *equal market shares which is unstable* and there are *two monopoly equilibria* with 100% market share for each format *being stable*. But which of the two monopoly equilibria will be reached is path dependent of early pitch and luck and can't be foreseen. The only fact to be foreseen is the certainty that the market will lock-in to a monopoly. There's no mechanism guaranteeing path efficiency.

5.3 How to Select a Monopolist? – A Theoretical Perspective

5.3.1 A General Stochastic Framework[33]

The concept of pitch and luck dependent on early 'pushes' and the multiplicity of long-run dominant structures and their selection process can be best explained by so-called nonlinear stochastic POLYA processes which are also very common in physics, biology and in the explanation of industry location patterns. In order to describe path dependent stochastic processes one has to distinguish between independent and dependent stochastic processes whereas dependent stochastic processes must be subdivided in path dependent and non-path dependent processes.

To distinguish independent from dependent stochastic processes, consider an urn with one white and one red ball. The probability the next ball being drawn is a red one is $p(r)=0,5$ and the probability of the white ball also amounts to $p(w)=0,5$. If the experiment is to be an *independent* stochastic process each ball which has been drawn will be laid back into the urn

[33] This paragraph is mainly based on ARTHUR, ERMOLIEV & KANIOVSKI (1997a), pp. 185-201 and ARTHUR, ERMOLIEV & KANIOVSKI (1997b), pp. 33-48.

so that the probabilities remain constant over time. Each drawing at any point of time is therefore independent of the past drawings and independent of the proportion of colours drawn up to now. Even after the one hundredth trial, probabilities are *p(r)=0,5* and *p(w)=0,5*. If one repeats the drawings indefinitely the proportion of the e.g. white balls will vary considerably at the start but will gradually reach *50%*. For example, after the first six drawings which could have the structure *w,r,w,r,r,r* the proportion of the white balls is *2/3* and the proportion of the red ones is *1/3* and does not coincide with the expectation value of the colours which are *E(r)=0,5* for the red balls and *E(w)=0,5* for the white balls. But after a great number of drawings the proportions of the colours drawn correspond with their expectation values. BOREL'S law of large numbers states that after a large number of repetitions which are independent of the previous drawings, proportions of the colours drawn from the urn converge to their expectation values, i.e. in the long-run the emergence of a structure with *50%* proportions has the probability *p=1*. And even if this experiment will be repeated once more again the result will remain the same. That means that early fluctuations in proportions do *not* influence the outcome, i.e. independent stochastic processes are *not* path dependent.

If the experiment is organised as a *dependent* stochastic process the probability of each new drawing must be dependent on the past drawings. One kind of dependent stochastic processes being at the same time a reference process for path dependent processes is the so-called standard POLYA process or the linear POLYA process named after the mathematician GEORGE POLYA. The linear POLYA process starts out with an urn with indefinite capacity whereas only two balls, a red one and a white one, are in the urn at the beginning. Each time one colour is drawn, one additional ball with the same colour will be added. At the beginning, probabilities of red and white colours are *p(r)=0,5* and *p(w)=0,5* , respectively. Suppose the first ball drawn is a red one; according to the rule, one additional red ball is added into the urn so that there are now three balls, two red ones and one white one. Consequently, the probability of each new drawing is dependent on all past drawings. The probability the next ball drawn is a white one decreased now from *p(w)=0,5* to *p(w)=1/3* and the probability that the next ball drawn is a red one increased from *p(r)=0,5* to *p(r)=2/3*. The linear POLYA example is a process with positive feedback because the probability of each colour to be drawn next increases with a growing proportion realized in the past. A dependent stochastic process with negative feedback would imply that the probability of each colour to be drawn next decreases with a growing proportion realized in the past. A very important feature with linear POLYA processes is the fact that at any time the probability that the next ball added is of a certain colour equals its proportion in the urn.[34] The main interesting question is whether the proportions of red and white balls move indefinitely over time between *0%* and *100%* or if there emerges a certain structure with stable proportions which do not change after they have been achieved. POLYA's result showed that such a dependent system will converge to a certain distribution of proportions with probability one. But the crux is that the stable proportion evolving over time is a random variable itself being distributed uniformly between *0* and *1*. That means for example, in the first experiment the long-run stable proportion is *5,8%* white balls and *94,2%* red balls and in the second experiment we will also converge to a long-run stable proportion but now with e.g. *47,95%* white balls and *52,05%* red balls. With a linear POLYA process, it is obvious that in the long-run one stable proportion will emerge but it is not possible to predict which structure will emerge. Thus, a linear POLYA process is a typical example of a *path dependent* stochastic process because the result, here the long-run stable proportion is determined by very early fluctuations in the system and can't be predicted. In fig.1 the linear POLYA process is plotted as probability function $p_1(x)$ whereas the horizontal axis shows the proportion of the red balls *x* within the urn and the vertical axis shows the

[34] For example, the probability that the next ball added is red exactly equals the proportion red within the urn.

probability that the next ball being added is a red one dependent on the proportion of the red balls in the urn *p(x).* As one easily can see the probability adding a red ball next equals always the proportion of red balls in the urn. Therefore each point of the linear POLYA function in fig.1 can be interpreted as a condition for the evolvement of a long-run structure or long-run stability condition since the proportion of a certain colour in the urn always equals the probability of this certain colour being added next so that the system stays where it is. Formally, the condition for long-run stability is $p(x)=x$ whereas x is distributed uniformly between *0* and *1*. Because of its path dependence feature, early fluctuations will determine which stable point on the 45-degree line will be achieved. But after a large number of drawings and a lot of balls within the urn, the influence of additional balls on the long-run outcome diminishes and therefore 'late' perturbations in the historical process aren't able to make this stable long-run structure lose its stability.

However, in order to explain the real word selection processes the linear POLYA process can't be employed since this kind of positive feedback described in the standard POLYA process does not fit the stylized facts. The standard POLYA case assumes that increasing returns operate in a linear way, e.g. that an increasing proportion of 20% of red balls raises the probability the next ball being added is red also by 20%. But reality shows that especially network effects operate in a *nonlinear* way because of *critical mass* effects in network markets. Generally, a network product, e.g. fax machines can only survive in the long-run if there are enough users since consumer utility and therefore demand depends on the amount of realizable network effects. Thus, at the introduction of a new network product in a market this product has to overcome a *critical mass* of users in order to generate enough network effects and sufficient demand to survive in the long-run. If this product isn't able to overcome the critical mass there are too few users to generate sufficient utility by network effects and as a result, the product doesn't have any chance to survive in the long-run. Therefore, with a relatively small market share, additional purchases of a network good can only generate small additional network effects since the critical mass hasn't been overcome yet. Demand is weak at the outset and as a result, the increase in probability of an additional purchase is very small. But if the critical mass has been overcome, additional sales create large increases in network effects since there are sufficient other network members making the network good very attractive to new consumers due to high increases in utility. The increase in probability of a new purchases grows overproportionally. However, with large market share it is true that additional users create additional network effects but the increase in utility grows underproportionally since also network effects can be subject to saturation. Consequently, critical mass also generates multiple equilibria with stable and unstable points: If a network good isn't able to overcome the critical mass point, the long-run stable outcome will be a market share of 0% since no one is willing to buy the product; but if the product is able to overcome critical mass, the network good will reach a market share of nearly 100% since utility is the biggest if all users use the same standard. A market share in between is an unstable outcome. Thus, the concept of critical mass comes to similar results as path dependence theory. By analogy with ARTHUR, the overcoming of the critical mass can be interpreted as early chance being able to take the lead.

In fig. 1 the S-shaped function $p_3(x)$ is subject to positive feedback since the probability the next ball being added is a red one increases with its proportion in the urn. The S-shape shows the critical mass effect since when proportion of red is very low (e.g. low market share of VHS) or very high (e.g. high market share of VHS) small improvements in the proportion of red balls (small improvements in market share) are assumed not to make much difference to the probability that the next ball being added is red (that the next videorecorder being bought is a VHS machine). But $p_3(x)$ also shows where the probability of being added next is higher than the proportion in the urn (points between proportion 0,5 and 1) the stochastic process tends to increase the proportion in the urn to 100% (point U will be the long-run

equilibrium); and where it is lower (points with proportion between 0 and 0,5), the proportion of red balls will decrease to a proportion of 0% (point T will be the long-run outcome). As a result, there are multiple long-run equilibria (U, X and T), but only two equilibria are stable (T and U) whereas the third one with equal proportions (point X) is unstable (the arrows indicate in which direction respectively towards which equilibrium the process will move). Consequently, with this kind of nonlinear positive feedback functions, the long-run stability condition $p(x)=x$ derived from the standard POLYA process is only a *necessary* condition for long-run stability because it doesn't distinguish between stable and unstable long-run equilibria. Which long-run equilibrium will be achieved (U or T) is path dependent on early random fluctuations and can't be predicted. The only fact which can be predicted is that a 'winner-takes-all' or 'loser-gets-nothing' solution will be achieved.

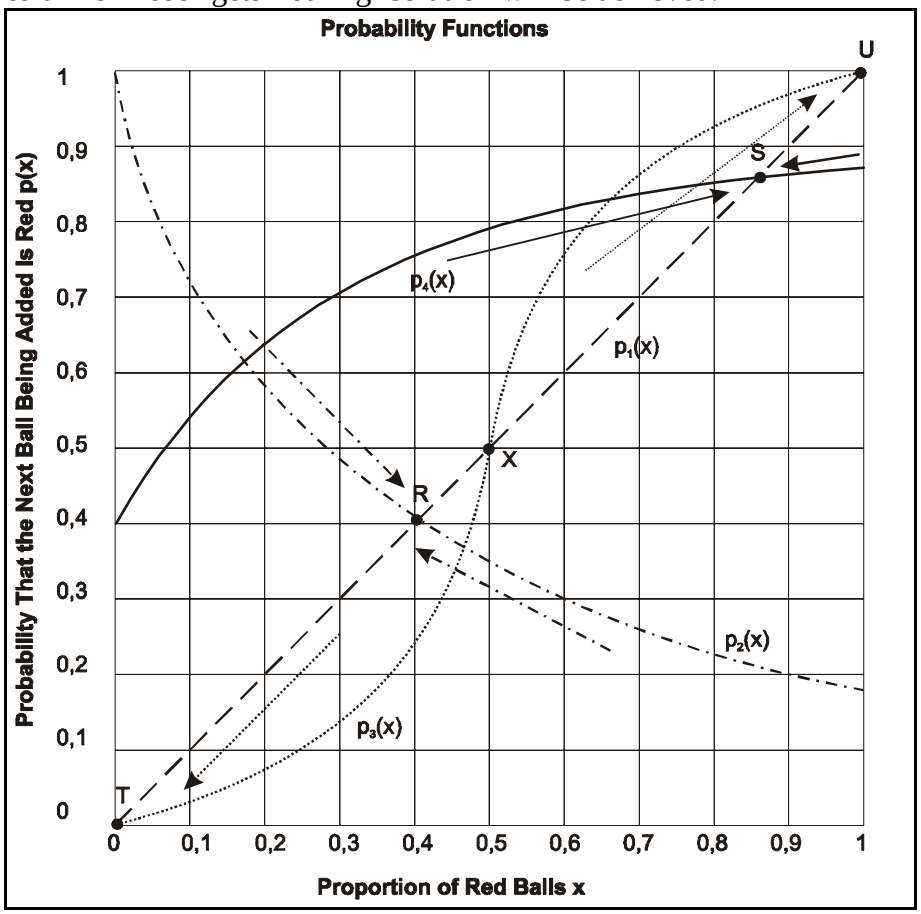

Fig. 1: Dependent Stochastic Processes.
Source: ARTHUR, ERMOLIEV & KANIOVSKI (1997b), pp. 39, 41 and own drawing (2001).

Another kind of nonlinear positive feedback function is described by $p_4(x)$. However, this function is not subject to critical mass effects since the positive increments in probability decrease over the whole range. There is only one possible long-run equilibrium in point S which satisfies the necessary long-run stability condition $p(x)=x$. Since there are no multiple equilibria this process is predictable, not path dependent, will end in point S with probability $p=1$ (indicated by the arrows) and no corner solution occurs (proportion red equals 100% or 0%).

Function $p_2(x)$ is an example of a dependent stochastic process subject to negative feedback. The probability that the next ball being added is a red one decreases with an increasing proportion. For example a data-network (perhaps the Internet) can be subject to negative network effects if additional users lead to overcrowding and to an deceleration of data services. This kind of process also possesses only one possible long-run equilibrium in point R. If the proportion of red is smaller than the probability of being added next

(proportions between 0 and 0,4) then the proportion will increase. If the proportion is higher than probability (proportions between 0,4 and 1) the proportion will decrease until equilibrium R is achieved. Due to the uniqueness of the equilibrium, this stochastic process is predictable, not path dependent and will not result in a corner solution.

5.3.2 A Model of Standard Selection[35]

This paragraph examines the dynamic allocation process of two competing standards under increasing and decreasing returns to scale.[36] Positive and negative feedback processes only stem from demand-side network effects which can be positive or negative; supply-side effects such as economies or diseconomies of scale are not considered. There are two competing but incompatible technologies *A* and *B* being introduced at the market and replacing an old-fashioned technology. Both standards are *unsponsored* and *embodied* technologies. Unsponsored technologies cannot be distributed and priced by a certain company because these technologies are open knowledge for all potential producers (e.g. knowledge of producing Intel-compatible PCs). An embodied technology doesn't exist as pure information but is embodied in physical capital (knowledge of producing computer hardware is embodied in chips, motherboards, hard drive disks, soundcards, etc.)

	Technology A	Technology B
R-type agents (natural preference for A: $a_R > b_R$)	$a_R + r\,n_A$	$b_R + r\,n_B$
S-type agents (natural preference for B: $a_S < b_S$)	$a_S + s\,n_A$	$b_S + s\,n_B$

Table 2: Payoff functions dependent on previous adoptions n_A and n_B of technology *A* or *B*.
Source: ARTHUR (1997b), p.17.

There is an infinite number of consumers which can be subdivided in two types *R* and *S* with equal numbers but different preferences. *R*-type consumers have a natural preference for technology *A*, *S*-type agents have a natural preference for technology *B*. The monetary utility an *R*- or *S*-type consumer derives from the choice of technologies *A* and *B* is modelled as a linear payoff function dependent on already bought units n_A and n_B of technology *A* and *B* given in table 2. Each payoff function consists of an autarky value a_i and b_i with $i=R,S$ and of a synchronization value being dependent on already sold units n_A and n_B of technology *A* and *B*. Since *R*-type agents have a natural preference for technology *A*, it is obvious that $a_R > b_R$; for *S*-type agents with natural preference for *B*, it holds that $a_S < b_S$. Variables *r* and *s* stand for the *direction* of network effects: $r,s > 0$ in the case of positive feedback (positive network effects), $r,s < 0$ in the case of negative feedback (negative network effects). The units n_A and n_B of technology A and B being already sold represent the *strength* of network effects: a larger number of previous adopters will generate additional/less monetary utility due to positive/negative network effects in the case of positive/negative feedback. Even if each group of agents has its natural preference for a certain technology it is also possible that e.g. *R*-agents buy technology *B* if sufficient positive or too much negative network effects overcome the natural preference.

Each consumer of type *R* and *S* has to replace his old-fashioned machine at a certain time t_i and buys only one unit of *A* or *B*, i.e. not all consumers replace their old machines at the same time but in a *random sequence*. It is important to note that this random sequence is an independent stochastic process with probability $p(R)=0,5$ that the next agent replacing his old technology is an *R*-type agent and with probability $p(S)=0,5$ that the next agent is of type *S*. Thus, one possible time sequence could be *R,R,S,R,S,S,S* but the sequence *S,R,R,S,R,S,R* is

[35] See ARTHUR (1997a), pp. 13-32.
[36] On the analogy of the previous paragraph, dynamic allocation processes subject to functions $p_2(x)$ (decreasing returns to scale) and $p_3(x)$ (increasing returns to scale with critical mass effects) in fig. 1 are compared with each other.

also possible. As mentioned above, these early random fluctuations or small historical events being *in*dependent stochastic processes are responsible for a non-predictable and path dependent outcome in the case of positive feedback. So, the sequence of agents buying a new machine is an independent stochastic process but the choice which type of technology will be bought next is a dependent stochastic process being positively/negatively influenced by the number of previous adoptions of technology *A* and *B* in the case of positive/negative feedback. Each variant of each technology isn't subject to future improvements so that the first adopter will get the same version as the ten millionth adopter. Technologies are further assumed as not being subject to depreciation.

In order to classify positive and negative feedback allocation processes some features have to be defined. *(1) Market share.* $n_A(n)$ and $n_B(n)$ stand for already sold units of technology *A* and *B*, being dependent on the total sum of all units $n = n_A + n_B$ which are sold. d_n indicates the difference in adoption between *A* and *B* with $d_n = n_A\,(n) - n_B\,(n)$. x_n calls for the *ex post* market share of technology *A* after $n = n_A + n_B$ has been sold. The ex post market share of technology *A* x_n can be expressed in dependence of d_n with $x_n = 0{,}5 + d_n / 2n$. *(2) Predictability.* The allocation process is said to be predictable ex ante if market shares of each technology can be foreseen despite of a random selection order. *(3) Path dependence*. If different selection orders of *R*-type and *S*-type agents lead to the same allocation outcome with probability one, then the selection process is said to be *not* path dependent since different early small historical events do not lead to different allocation outcomes. *(4) Flexibility*. The allocation process is flexible if subsidies or taxes on payoffs can always influence the decisions of future purchases in favour of a certain technology. The amount of taxes or subsidies has to remain small and constant, e.g. less than a constant *k*. *(5) Path efficiency.* The allocation process is said to be path efficient if at all times equal development of the technology which is behind would *not* have led to higher payoffs.

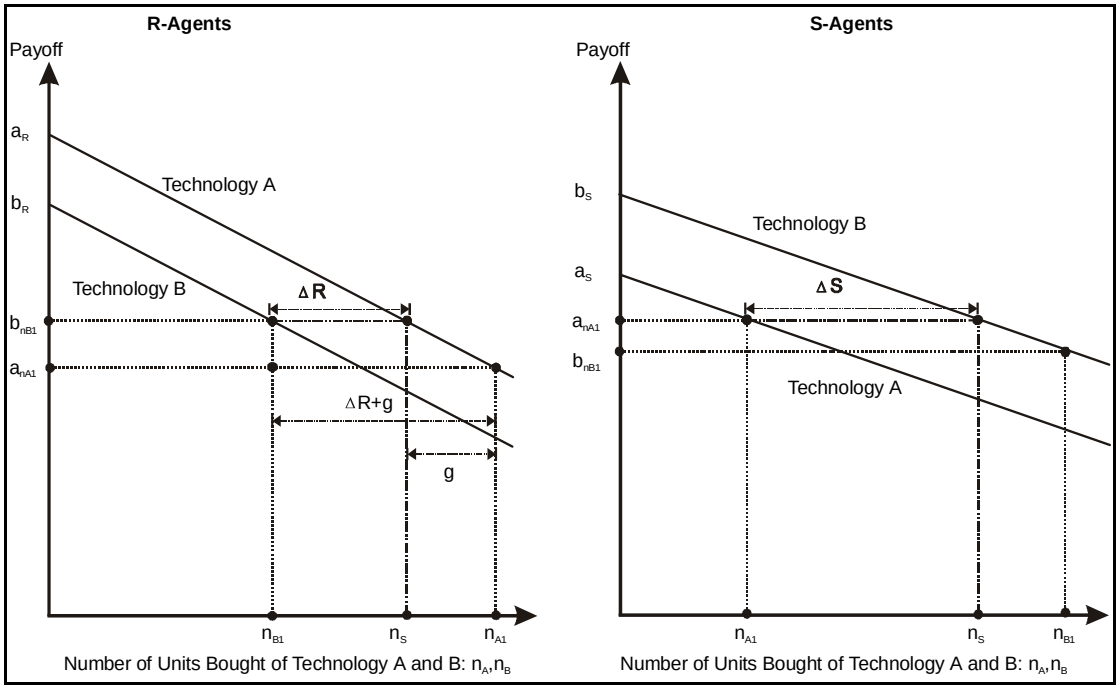

Fig. 2: Payoff functions under negative feedback. Source: ARTHUR (1997b), p.21 and own drawing (2001).

Figure 2 illustrates the payoff functions in the *negative feedback* case. Each additional unit of technology *A* and *B* being bought diminishes payoffs of *R* and *S*-agents. In order to examine if the market tips into one single technology, it is necessary to determine under which circumstances all agents, *R* and *S*, chose the same technology. Thus, it is necessary to define the point where agents switch between technologies *A* and *B*. For example in figure 2, *R*-type agents preferring technology *A* will receive a payoff of a_{nA1} if n_{A1} units have been sold.

Assuming that only n_{B1} units of technology *B* have been sold, *R*-agents could earn a higher payoff b_{nB1} by switching to technology *B* since technology *B* generates less negative network effects. From there, assuming that e.g. n_{B1} units of technology *B* have been already adopted, *R*-agents will switch to their naturally less preferred technology *B* if the critical difference in adoptions between technology *A* and *B* amounts to $n_S - n_{B1} > \Delta R$. In our example the switching condition is met since $n_{A1} - n_{B1} = \Delta R + g > \Delta R$. Generally, switching conditions are: *R*-type agents will switch from *A* to *B* if it holds that $d_n = n_A(n) - n_B(n) > \Delta R$, and *S*-type agents will switch from *B* to *A* if it holds that $d_n = n_A(n) - n_B(n) < -\Delta S$.

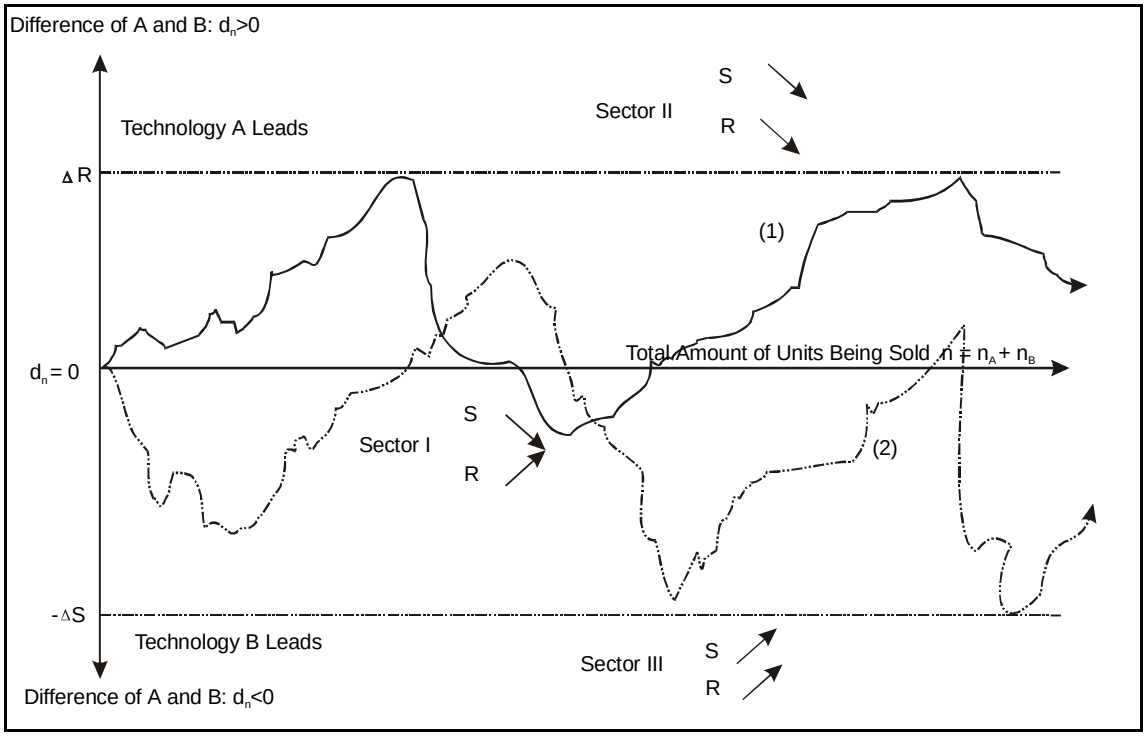

Fig. 3: Allocation processes under negative feedback. Source: ARTHUR (1997b), p.22 and own drawing (2001).

Figure 3 shows the dynamic allocation and selection process under negative feedback. On the vertical axis, d_n stands for the difference in adoption and ΔR and $-\Delta S$ for the critical switching differences. The horizontal axis shows the total number of adoptions of technologies *A* and *B*, $n=n_A + n_B$ and can also be interpreted as a time axis. Assuming that both technologies start up with equal market shares, figure 3 shows two possible selection processes (1) and (2) out of an infinite number of other possible selection processes. Which selection process actually takes place is determined by the independent random selection sequence of adopters. There are three distinct sectors being subdivided by the critical switching differences ΔR and $-\Delta S$ where buying decisions differ. The arrows indicate the direction of choice of *R* and *S*-type agents. In *sector I*, each type of agent chooses its naturally preferred technology since the switching barriers are not reached yet; *R*-agents choose *A* and *S*-agents choose *B*. In *sector II*, R-type agents will switch to technology *B* since there are too much technology *A* adopters generating a comparative disadvantage for technology *A*. *S*-type agents will choose technology *B* anyway. In the case of negative feedback, ΔR acts as a *reflecting barrier* which can't be overcome since if technology *B* is becoming dominated by technology *A*, the allocation process is 'pushed' back by ΔR in favour of technology *B*. In *sector III*, *S*-type agents will switch to technology *A* because technology *A* being naturally less preferred is able to provide higher payoffs due to relative high negative network effect with technology *B*. *R*-type agents choose technology *A* anyway. Thus, $-\Delta S$ also acts as a *reflecting barrier* which 'protects' the allocation against tipping completely into technology *B*. As a result, ΔR and $-\Delta S$ prevent the market from tipping into one technology. Sectors II and III

can't be overcome since always the technology being 'behind' will be supported by both types of agents. There is no lock-in to a certain technology. For a very large amount of total adoptions *n*, technology *A*'s market share $x_n = 0{,}5 + d_n / 2n$ will converge to 50% since the term $d_n / 2n$ converges to zero for $n \rightarrow \infty$. Therefore, the allocation process is predictable because in the long-run, both technologies will end with equal market shares. The allocation process is not path dependent since in the long-run, different allocation processes, here (1) and (2), lead to the same outcome with 50% market share for each technology. Taxes or subsidies of a constant amount less *k* are able to shift the reflecting barriers ΔR and $-\Delta S$ and therefore influence future buying decisions. Since agents are always interested in choosing the technology to yield the highest payoff and no tipping is possible, the process is path efficient as there is no possibility of an inefficient technology mix.

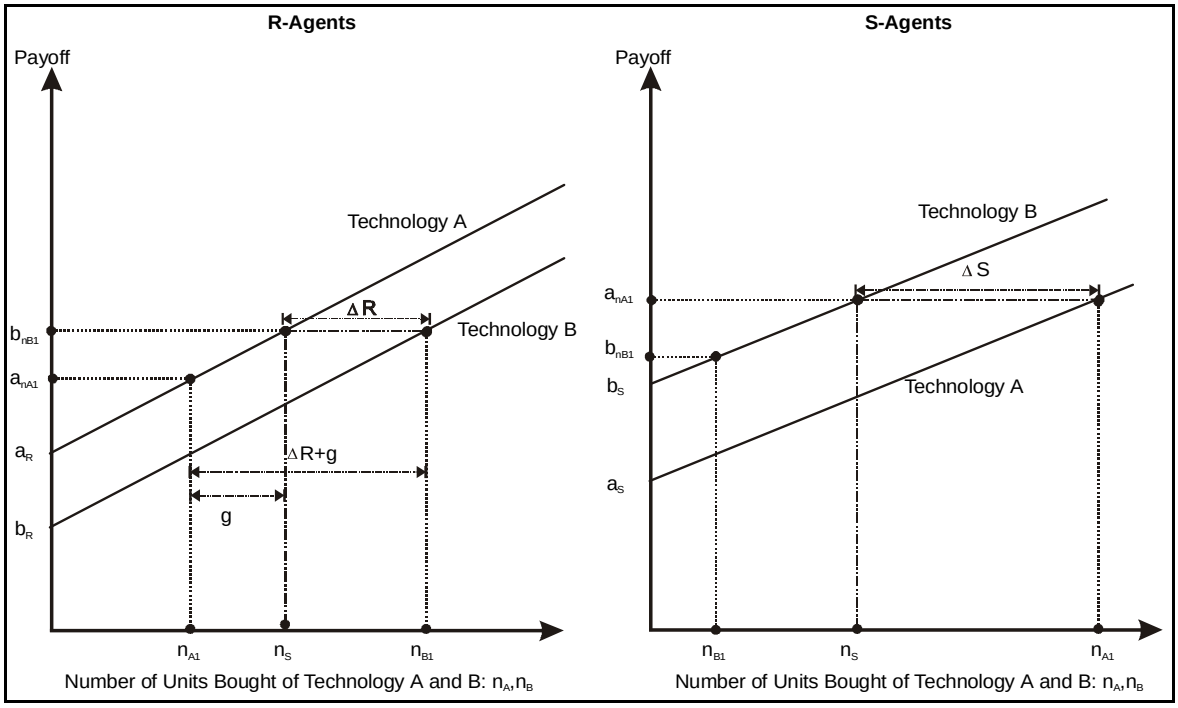

Fig. 4: Payoff functions under positive feedback. Source: Own drawing (2001).

Figure 4 illustrates the payoff functions of *R*-type and *S*-type agents under *positive feedback*. In contrast to figure 2, the parameters *r* and *s* are positive due to positive network effects. Each technology is more valuable if there is an increasing number of adoptions. As in the negative feedback case, it is necessary to determine the switching condition in order to explain the dynamic allocation process. For example, *R*-type agents preferring technology *A* would yield a payoff of b_{nB1} if n_{B1} units of technology *B* had been sold. But if only n_{A1} units of technology *A* have been sold, *R*-type agents only earn a payoff of a_{nA1} and therefore are willing to switch to technology *B*. From there, assuming that n_{B1} units of technology *B* have been already adopted, *R*-agents will switch to their naturally less preferred technology *B* if the critical difference in adoptions between technology *A* and *B* amounts to $n_{B1} - n_S > \Delta R$. In our example the switching condition is met since $n_{B1} - n_{A1} = \Delta R + g > \Delta R$. Generally, switching conditions are: *R*-type agents will switch from *A* to *B* if it holds that $d_n = n_A(n) - n_B(n) < -\Delta R$ and *S*-type agents will switch from *B* to *A* if it holds that $d_n = n_A(n) - n_B(n) > \Delta S$.[37]

[37] Due to the change in signs with ΔS and ΔR in comparison with the negative feedback case, barriers in figure 5 are reversed in comparison with figure 3.

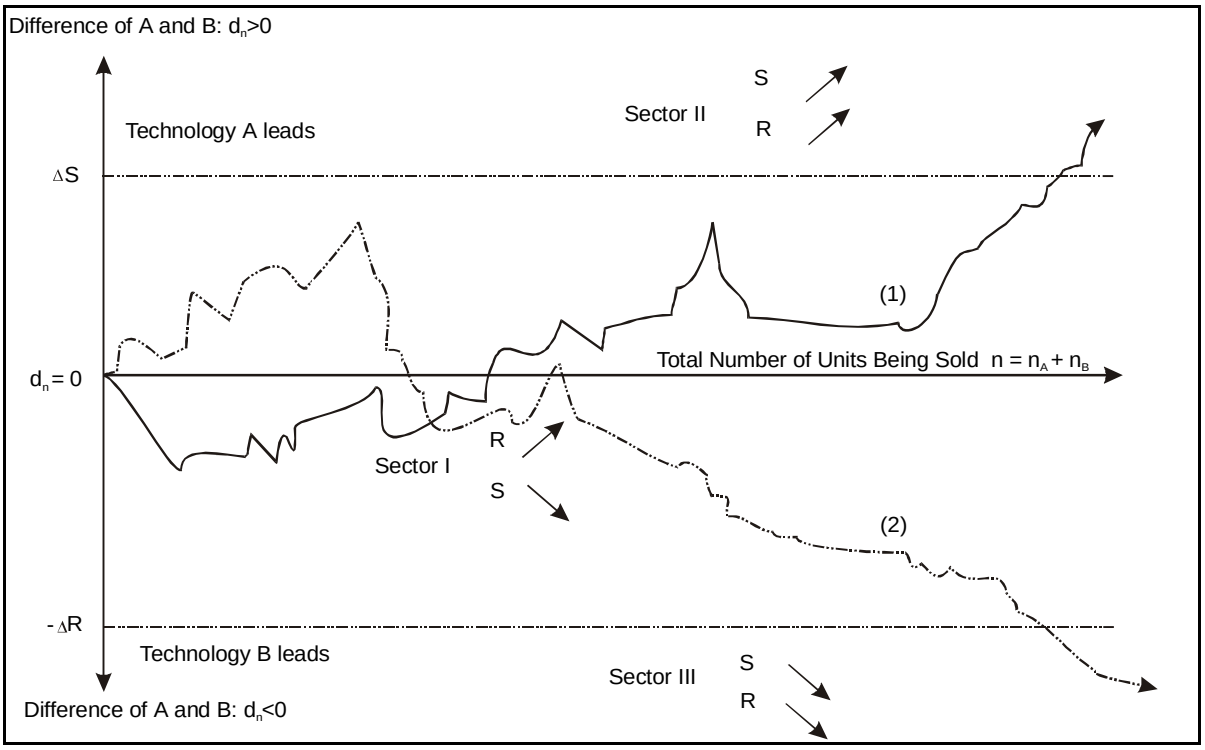

Fig. 5: Allocation processes under positive feedback. Source: ARTHUR (1997b), p. 23 and own drawing (2001).

In figure 5 two different allocation processes, (1) and (2), are presented which also stem from the random selection sequence of *R*-type and *S*-type adopters. Both technologies are assumed to start up with equal market shares. As in figure 3, switching barriers -*ΔR* and *ΔS* subdivide three different sectors due to changing choice decisions. In *sector I*, both types of agents select their preferred technology; *R*-agents choose *A* and *S*-agents choose *B*. In *sector II*, *S*-type agents are willing to switch to technology *A*; *R*-agents stay with technology *A*. At *ΔS*, both types of agents will choose technology *A* being in the lead so that if *ΔS* once is reached, technology *B* won't have a chance any longer of gaining market share. As a result, *ΔS* doesn't take effect as an reflecting barrier but as an *absorbing barrier* and the market will tip into technology *A*. In *sector III*, both types of agents will choose technology *B* since at -*ΔR*, *R*-type agents switch from *A* to *B* and *S*-agents choose technology *B* anyway. Thus, if technology *B* is inspired by luck respectively by the random selection sequence to gain a high market share at an early stage of time (history matters!), the market will tip or lock-in to technology *B*. The absorbing barriers -*ΔR* and *ΔS* result in monopolistic and lock-in outcomes which can also be expressed as 'winner-take-all' and 'loser-gets-nothing' solutions. An outcome with equal market shares is not possible since there are no reflecting barriers. Only random selection sequences of *R*- and *S*-adopters determine the market outcome, e.g. allocation process (1) will end in a lock-in solution for technology *A* and the allocation process (2) results in a lock-in monopoly for technology *B*. Thus, allocation processes under positive feedback are path dependent on early random fluctuations. Since there is no possibility to determine which technology will 'win' the process is not predictable. There is no mechanism guaranteeing an efficient outcome since only early pitch and luck determine if the superior or the inferior technology measured by payoffs will win. As a result, there is always a possibility of path inefficiency. If the allocation process 'selected' the inferior technology, subsidies and taxes in order to promote the superior technology would have to increase without a bound because the barriers -*ΔR* and *ΔS* would have to be shifted more and more outwards. A constant amount less *k* is not able to influence always future buying decision, therefore the process is not flexible. Table 3 summarizes the results of the different features under positive and negative feedback allocation processes.

	Predictability	Flexibility	Path Dependence	Path Efficiency
Negative Feedback	*Yes*	*Yes*	*No*	*Yes*
Positive Feedback	*No*	*No*	*Yes*	*No*

Table 3: Features of allocation processes under positive and negative feedback. Source: ARTHUR (1997b), p. 23.

5.3.3 Is There an Exit from Lock-In?

The general stochastic framework and the simple model of standard selection both explain the evolution of a perhaps inferior lock-in monopoly under increasing returns to scale. However, there is no statement if such an inferior solution can be overcome at all and if it was possible to overcome, how much costs must be borne.

ARTHUR states that if technologies are subject to learning effects and/or large irreversible and specialized fixed costs a switch to the superior path would be almost impossible. For example, knowledge-based goods or capital-intensive goods such as computer software, hardware, telecommunication equipment, pharmaceuticals, aircrafts, etc. are subject to huge R&D irreversible fixed investment costs and low marginal costs (static economies of scale). A switch to an alternative but incompatible technology would mean huge losses due to sunk investments and renunciation of economies of scale. Network effects being tied to specialized fixed capital can also be interpreted as irreversible fixed costs since investments in a certain standard are mainly made to reduce incompatibility costs. A switch to another technology would eliminate all existing network effects and impose huge switching costs by the establishment of a new standard. For example, altering the width of railroad tracks won't be possible because of invincible additional costs. In addition, knowledge-based and capital-intensive goods require complementary irreversible investments in human capital since these products can often only be used efficiently with an intensive education. Thus, switching to another incompatible technology will be very unlikely. Knowledge-based goods also often contain an enormous potential for learning effects. On the supply side more output is usually connected with more experience in the manufacturing process leading to lower production costs (dynamic economies of scale or process innovation). Further, increased knowledge of a certain product or technology can make it easier to produce improved technologies (product innovation). On the demand side the more a product is used the easier it will become to use it in the future. Consequently, switching to another technology will be very costly. Even in a situation where users of a common technology would be willing to bear switching costs, a change to another standard could be impossible due to a lack of coordination between the individual users since no one wants to be the first adopter of a new technology being uncertain if other users also switch.[38]

Where common standards are not subject to specialized fixed costs and learning effects, a switch to the superior technology should be possible. For example, it would be very easy to adopt the rule turning right on a red light in road traffic. But the prisoner's dilemma also has to be overcome by an institution being able to lower coordination costs.

5.3.4 Policy Implications

Under negative feedback there's no reason to intervene in the allocation process because decreasing returns to scale prevent markets from tipping and guarantee that agents always have the possibility to select superior technologies. If a single technology was able to dominate a market this could be only due to superior quality or higher payoffs. In this case, a dominant market position is justified because of economic efficiency and the market can easily be locked-out by a competitor offering the same or even better quality (payoff) since

[38] This problem was mentioned earlier under the headword 'prisoner's dilemma'.

the incumbent has a comparative disadvantage due to a large installed base (large negative network effects).

In the case of positive feedback, laissez-faire policy cannot guarantee 'a survival of the fittest technology'. Dominant market positions can be achieved simply by luck and not by economic efficiency and in most cases there's no possibility of locking-out since the incumbent is protected by huge switching costs due to network effects and irreversible investments. There are two policy options. First, a super-agent set up by regulation authorities could steer technology adoption in the direction of superior standards by providing subsidies for promising technologies and imposing taxes on inferior standards. Especially European and Japanese governments pursued such an industrial policy.[39] However, the snag is that super-agents often can't assess the payoffs of different technologies over the next 20 years better than private agents. Second, a very restrictive antitrust policy could be established preventing markets from tipping in early stages in their evolution and thereby guaranteeing that different technologies could be observed over a longer time so that it would become possible to pick out the superior technology. In order to ensure an efficient economic outcome, the picked winner could be regulated preventing him from pursuing monopolistic and anti-competitive practices.

5.4 Microsoft, the District Court and "Arthurnomics"

Though the court doesn't mention the theory of path dependence explicitly, there is a lot of circumstantial evidence that the underlying economic theory is heavily built on BRIAN ARTHUR'S work.

First, the court argues that a positive feedback loop due to static economies of scale and demand-side network effects led to the so-called intractable 'chicken-and-egg' problem which caused a 'Microsoft-winner-take-all' and a 'Mac-OS/2-Linux-loser-gets-nothing' solution.[40]

Second, Microsoft is blamed *implicitly* for being an inferior lock-in standard *today* due to positive feedback. There is no explicit statement claiming that Microsoft gained its dominant market position simply by chance and was able to oust Apple in the battle for the predominance in the OS market in the mid 1980s. There's also no explicit statement that Microsoft would have been an inferior technology inspired by early luck in comparison with its early competitors in the mid 1980s. Concerning the early technology selection problem during the standard battle between Microsoft and Apple, there's no link with ARTHUR's theory within the court's argumentation. As a result, Microsoft is not explicitly blamed for having been an inferior solution *in the past.* But Microsoft is *implicitly* blamed for being an *inferior lock-in standard today* who gained its dominant market position in the *past* by *positive feedback* and whose predominance is protected by the applications barrier to entry. The court claims that Apple Macintosh, OS/2 and Linux haven't been able to overcome the applications barrier to entry which implies that these alternative OSs are thought to be at least of the same or even of better quality than Windows because no competitor with worse quality could compete effectively with the incumbent. In this respect, the court argues completely according to ARTHUR's theory that there's almost no possibility to 'unlock' the Microsoft monopoly. The judge doesn't mention explicitly the term 'inferior lock-in monopoly' but also demonstrates that Microsoft isn't believed to survive due to superior product quality but simply by anti-competitive means which protect and enhance the applications barrier to entry.

Third, the proposed break-up remedy also makes sense in the light of path dependence theory. The AppsCo-OpsCo solution is supposed to end the inferior lock-in monopoly and

[39] For example the AIRBUS-INDUSTRY in Europe is one of the largest industrial policy efforts. In Japan, the MITI (the Japanese Ministry of International Trade and Industry) pursued a very restrictive industrial policy.

[40] See for this argumentation JACKSON (1999), U.S. Department of Justice, Antitrust-Division, p. 6.

give rise to new viable alternatives to Windows. Regulation or conduct restrictions wouldn't have been able to overcome the lock-in situation and induce competition.

CHAPTER III. CRITICAL ASSESSMENT OF THE DISTRICT COURT'S DECISION[41]

6. Assessment of the Applications Barrier to Entry and Lock-In to Microsoft

6.1 Quality Overcomes History – Real World Evidence

Path dependence theory claims that locking-in to an inferior standard *can* be an allocation outcome but there is also the possibility that the superior standard is 'selected by chance'. Usually, proponents of path dependence underpin their theory by empirical examples like the VHS-Betamax example or the Mac-PC-history. Other examples claim that we are all locked-in to an inferior typewriter keyboard standard,[42] that the computer language FORTRAN would be an inferior technology or that the United States would be locked-in to inferior nuclear light-water reactors whereas high-temperature, gas-cooled reactors would have been much better. Though, these examples give the impression that there is *always* a tendency towards inferior lock-in standards and that success of a superior technology would be an event with a very small probability, so that history would favour inferior solutions.

However, critical investigations of these empirical examples by LIEBOWITZ & MARGOLIS show that path dependence theory proponents only told the half truth. For instance, in the VHS-Betamax example, ARTHUR states that

> *"both systems were introduced at about the same time and so began with roughly equal market shares."*[43]

ARTHUR needs this statement in order to prove that early random events determined the long-run inferior result. However, Sony began selling Betamax in April 1975 and enjoyed a monopoly position for about two years. JVC began selling its VHS system in summer 1977 and was able to gain the same market share as Betamax within six months and supersede its rival in the long-run.[44] The reason for VHS's rapid success was a longer tape recording capacity of four hours which enabled consumers to record full-length feature movies whereas the Betamax system offered only a tape capacity of two hours. If path dependence theory was able to portray real world processes in a correct way, the common videorecorder standard today would have to be Betamax since Sony enjoyed a first mover advantage. Within a two year monopoly, Betamax would have been able to lock-in consumers to a superior standard as always claimed and VHS never would have had any chance to overcome this superior lock-in position. As a result, it seems that quality aspects *do* play an important role in consumer decision processes and that there's no indication of an inferior technology lock-in since markets seem to be contestable despite of increasing returns to scale. Further, there's no sign of long-run lock-in to a single technology in the videorecorder market since the digital DVD-standard providing a far better picture quality will likely erode the VHS-standard in the near future despite of high switching costs due to incompatibility of VHS-cassettes and DVD-Roms.

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[41] An additional economic analysis of the Microsoft case concerning the assessment of market power, exclusionary behaviour, predatory conduct, Microsoft's pricing strategy an tying can be found in the Microsoft symposium papers by KATZ & GILBERT (2001), KLEIN (2001) and WHINSTON (2001).

[42] See DAVID (1985), pp. 332-337.

[43] See ARTHUR (1997a), p. 2.

[44] However, VHS was not able to replace Betamax completely. For example, in Indonesia the common videorecorder standard is Betamax and not VHS.

As to the Microsoft case, it is always alleged that the Macintosh OS was far superior to the old command-line DOS OS and even to the current DOS-based Windows OS but wasn't able to compete effectively due to consumer lock-in. The court doesn't mention explicitly that Windows is an inferior lock-in standard but assumes that Macintosh would be able to compete effectively in the case of an absence of the applications barrier to entry. Normally, consumers prefer graphical user interfaces instead of command-line-based OSs. So how could the command-line-based DOS OS dominate the Macintosh graphical user interface? Surely, one answer would be a random lock-in to an inferior standard, but this argumentation is too shortsighted. Actually, the command-line DOS had essential advantages over the graphical-based Macintosh OS. First, DOS had a cost advantage over Macintosh. Because of its graphical user interface, Mac needed much more computing power than DOS; moreover, the Mac OS required PostScript printers being 1000 US-$ more expensive than usual laser printers which could be used for DOS applications. Second, command-line DOS was faster than Mac. Third, it was much easier and less expensive to develop application software for the DOS OS than for the Macintosh OS. Fourth, there was no backward compatibility of Macintosh and therefore no possibility to edit files being created under an older version. Finally, Apple didn't seek continuity in its development of OSs. Apple released two incompatible OSs in short order, first an OS called Lisa and then Macintosh. Thus, consumers were uncertain over the future development of Apple's OSs. After improved computing power had become cheaper there was a rapid movement from DOS to the graphical-based Windows platform because the advantages of DOS over Macintosh diminished. If Microsoft had not moved from DOS to Windows when hardware power became much cheaper, Macintosh would have become the dominant standard today. If we were still using command-line DOS today despite the fact of cheaper computing power and a superior Mac system, only then consumers would be locked-in to an inferior standard. As a result, in real world markets there's no lock-in to an inferior standard, quality is the critical competitive factor (compatibility, costs, etc.) and technological change can erode dominant market positions very quickly.[45]

The court also stated that OS/2 had had no chance to compete effectively with Windows due to the applications barrier to entry. Behind this assertion, there is also the implicit idea that Windows is an inferior lock-in monopoly. But the failure of OS/2 was not only due to consumer lock-in. By the time of introduction of OS/2, there were much more applications available for OS/2 than for Windows at the beginning. But experts also claim that OS/2 was only a half-baked OS for consumer use because it was difficult to install, much more expensive than Windows, required twice as much memory and a faster processor, wasn't compatible with many video and soundcards and the networking version of OS/2 ran only on IBM machines with the so-called Micro-Channel-Architecture.[46]

One important point missing in the court's assessment of the case is Microsoft's success with its Microsoft Office package and especially with Microsoft Word and Excel. Generally, word processing and spreadsheet software are the mainstays of application software. As mentioned in paragraph 5.1, Windows versions 1.0 and 2.0 weren't able to succeed due to lacking quality. Consumers remained using command-line DOS. But when Windows 3.0 (with essential improved quality) was introduced, Microsoft needed sufficient applications written for it to succeed and to overcome DOS. One of the main strategies was to port its own successful products Word and Excel over to Windows 3.0 which had been very successfully introduced *earlier* in the Mac OS market. As in the Mac OS market, Word and Excel could gain a dominant market position within a relative short period of time. Thus, one of the most important factors of gaining a dominant market position in the OS market was Microsoft's success due to high quality with its own application software which was also available for the

[45] See LIEBOWITZ & MARGOLIS (1999), pp. 120-129.
[46] See LIEBOWITZ (2001), p. 4.

competing OS system Mac. Microsoft's success seems again to stem from superior quality and not from random events.

LIEBOWITZ & MARGOLIS[47] who doubt ARTHUR`s theory, tested software markets for potential inferior lock-in and resistant, dominant market positions. They observed among the two largest software application markets, word processors and spreadsheets and also markets for desktop publishing software, personal finance software, Internet browsers and online services. They were especially interested in Microsoft's market position within each market. Their main results can be summarized as follows:

(1) Microsoft's Word and Excel were able to erode very quickly the dominant market positions of WordPerfect and Lotus and became the dominant products. Different computer magazines ranked Word and Excel in most cases as the best products.

(2) Microsoft was only successful when it produced better products at lower price. For example, Microsoft wasn't able to erode Quicken's dominant market position for personal finance software. Furthermore, network effects in personal finance software don't seem to be as important as in other software markets since there is less need for exchanging files. As a result, this market showed not a 'winner-take-all' but a 'winner-takes-most' by providing better quality solution.

(3) In other software markets, product quality also seemed the key to success, even in the OS market. Inferior ranked products lost market share very rapidly. For example, many desktop publishing (DTP) professionals prefer Mac-based DTP software and not PC-based DTP software due to higher quality. One reason for Mac's success with DTP software users is that Mac has a longer experience with graphics since Macintosh was the inventor of graphical user interfaces and therefore the invention basis of many desktop publishing (DTP) software. One couldn't also observe any lock-in the Mac-based DTP software. For instance, Mac-based Quark Express, a high-end desktop publishing software was able to erode very rapidly the dominant market position of Mac-based Page Maker after its introduction and was always ranked as the best Mac-based DTP software. In the PC-based DTP software market, there was no clear quality leader in the 1990s, a situation having at the same time being reflected in market shares; PC-based Page Maker was ranked higher than PC-based Quark and holds a market share of about 50% whereas Quark has a market share of 35%. The fact that two products are ranked differently in different OS markets and that their quality ranking is reflected exactly in market shares is a further indication of contestable positive feedback markets. In the mid-range lower-price DTP PC software market Microsoft could gain market leadership with its product MS Publisher which was also ranked as the best mid-range DTP programme. In the online services market, AOL could gain very rapidly market share whereas CompuServe and Prodigy lost their dominant market position. AOL's gain in market share was also accompanied by a high quality ranking.

The overall conclusion considering quality, inferior lock-in and resistance of incumbents is that product quality is the key to success, inferior products lose market share very rapidly, there's no lock-in since in most cases benefits of innovation outweigh the losses of incompatibility (switching costs), dominant market position can be eroded very quickly by providing better quality. There's also no indication of total lock-in to one single standard since due to buyer heterogeneity and differences in tastes niche products are able to coexist next to dominant market leaders, e.g. Mac vs. Windows in DTP and OS/2 vs. Windows in banking software.[48]

[47] See LIEBOWITZ & MARGOLIS (1999), pp. 135-234.

[48] As mentioned before, a lot of application software in financial services is based on IBM's operating system OS/2.

LIEBOWITZ & MARGOLIS provided also interesting insights in Microsoft's pricing behaviour and in Microsoft's overall impact on prices in software markets. The main findings were:

(1) As WordPerfect and Lotus were still market leaders in word processing and spreadsheet markets, prices were high. When Microsoft became the leader, prices fell. Such a development is consistent with a change to a very competitive regime.

(2) In the late 1980s, Microsoft was dominant in the Macintosh market with Word and Excel but had very low market share in the PC market. Economic theory would predict a higher price for Macintosh products but evidence showed that Mac users paid prices for Word and Excel which were 25% lower than PC prices where Microsoft was price follower.

(3) In order to examine Microsoft's pricing behaviour in dependence on Microsoft's influence on competition, software was grouped into three different market categories: First, markets where Microsoft is a direct competitor (e.g. word processing, spreadsheets, personal finance, midrange desktop publishing); second, markets where Microsoft competes with Windows (e.g. utilities, communication); third, markets where Microsoft doesn't compete at all (e.g. high-end-desktop publishing, accounting). In the period from 1988 until 1995, software prices fell in general but there are important differences among the markets. In markets with Microsoft competition, prices have declined by 60%. In markets without Microsoft competition, prices have fallen only by an average of 15%. As a result, Microsoft can be hold responsible for price declines in software markets.

The conclusion on Microsoft's pricing behaviour is that Microsoft lowered prices after it became the market leader. Microsoft charged lower prices in markets it controlled than in markets with no dominant market position. Markets with Microsoft's direct or indirect competition have showed an enormous decline in prices.

Summing up, there's no evidence of inferior quality lock-in in real world markets. Software markets are contestable even in the short-run since better quality wins quickly, market-share swings in software markets are large and rapid and triggered by changes in quality. Sometimes market leadership is eroded by Microsoft, sometimes by another company. Microsoft enjoys dominant market positions where product quality is ranked as best. There's no evidence of consumer harm by Microsoft since each time after Microsoft became market leader prices began falling rapidly.

6.2 Software Markets as SCHUMPETERIAN Industries

As empirical evidence shows, software markets aren't characterized by permanent lock-in monopolies but by *serial temporary monopolies* due to SCHUMPETERIAN processes of *creative (quality-)destruction*. Software markets seem to be contestable even in the short-run. As mentioned above, one reason for serial temporary monopolies is the possibility that demand side switching costs can be overcome very easily by better product quality.

Another reason may stem from overestimated supply side static economies of scale. As already explained, some economists and above all ARTHUR argue that high-tech-industries and especially software markets are subject to almost inexhaustible static economies of scale which result in natural monopolies. Their assertion is based upon two well-known observable phenoma in high-tech markets: enormous declines in price in connection with huge growth rates in sales. This phenomenon was observable for example in videorecorder, fax machine, computer hardware, computer software, and in telecommunication equipment markets. Surely, high-tech or knowledge-based products are associated almost entirely with fixed costs and computer software also seem to fit this fact: programming costs are large and costs of copying are very small. But as argued in traditional industrial sectors, economies of scale *do*

have a limit, even in software industry because costs of attending a new customer aren't restricted to production costs. There are also service and technical support costs, marketing costs, and with a huge number of sold pieces mathematical observable decreases in costs become insignificant from an economic perspective. Thus, software industries can be viewed like many older industries as television, radio, books, etc. which can realize economies of scale about a wide output range but are subject to diseconomies of scale from a certain point on.

Another reason for the emergence of serial monopolies are product and process innovations. As defined before, process innovations or dynamic economies of scale stand for a downward shift of the LRATC and can be interpreted as technological progress. Still, dynamic economies of scale don't necessarily imply static economies of scale. An observable decline in prices and expansion in output could also have its origin in a downward shift (technological progress) of a cost curve which is characterized by *dis*economies of scale (for example an upward sloping or U-shaped cost curve).[49]

Another reason for the emergence of serial temporary monopolies and the high speed of changes in market leadership stems from *instant scalability*, i.e. the fact that software industry in general is able to alter its output scale very rapidly without any considerable additional costs of expanding output. Especially industries providing knowledge-based products need only very little incremental capital equipment to increase output. For example, an increase in software production only needs additional hard drives or Internet connections whereas an increase in automobile output requires additional specialized fixed investment. Therefore, in standardisation battles, market entry and exit can occur very fast due to absent essential output scale costs. In addition, products providing best quality will dominate the market before imitators are able to copy the essential quality features.[50]

The overall conclusion is that there's no real world evidence for lock-in theories in markets subject to increasing returns to scale. Software markets correspond to SCHUMPETER's view of temporary and serial monopolies which are frequently swept aside by a process of creative destruction. Competition is not mainly driven by price but by new products and new technologies. Markets are contestable and temporary monopolies are necessary to offer incentives for technological innovations as a driving force of growth. Empirical evidence in software markets shows that:

(1) Static software competition is characterized by selling existing products; dynamic competition marked by adding features to existing products or inventing new products.
(2) Quality (speed, compatibility, features, reliability) is the key to success.
(3) Network effects, static and dynamic economies of scale and instant scalability lead to dominant market positions with 'winner-take-all' and 'loser-gets-nothing' outcomes. However, winners and loser are not selected by chance but by superior product quality. If there is strongly developed product heterogeneity 'winner-take-most' solutions occur.

[49] In the past, public utilities being network industries as well, such as generation and distribution of gas, electricity, water, railway, airline services, telecommunications, etc. were also assumed to exhibit natural monopoly features, since the building of a network-infrastructure was also subject to huge fixed investments and marginal costs were low. Due to large sunk costs there were fears that these monopolies would become resistant. Since services of most public utilities are of high public interest (gas, water, electricity provision) these monopolies have been regulated by the state. However, technological progress (dynamic economies of scale) as another 'natural' market force, has changed cost structures so that especially production of public utility services such as the generation of electricity is no longer subject to subadditivity whereas transportation and distribution still have natural monopoly features. The result has been the decision to deregulate public utility industries with separating the economies of scale parts of those industries from the rest. In most cases, infrastructure has remained being regulated by state (e.g. telephone network infrastructure) but production (e.g. suppliers of telephone services) was restructured and opened to competition. Today, regulation authorities have to ensure a fair access for competitors without any discrimination to the infrastructure or the so-called 'bottleneck-facility'.
[50] See LIEBOWITZ & MARGOLIS (1999), pp. 136-137.

In the case of OSs, Windows hasn't been able to dominate the entire market. Heterogeneous preferences allow niche products such as Macintosh, Linux and OS/2 to survive next to a near monopolist. While demand side synchronization effects favour the domination of a single standard this condition is not sufficient to guarantee such a result due to e.g. diseconomies of scale in production.

(4) Lock-in due to high switching costs doesn't seem to be as important as claimed by path dependence theorists. In high technology markets, the pace of innovation is high and today's monopolists are often replaced very quickly by better products. For example, in the OS market, MS-DOS displaced CP/M, and after a battle with OS/2, Windows displaced MS-DOS. All these displacements were mainly caused by major innovations. As a result, there is no evidence for a slow down in the pace of innovation in software markets.

(5) Innovation in software markets often takes place by adding new features to existing programmes. Since software is a durable good, i.e. not being subject to depreciation and a gradual loss of quality, software companies are forced to improve their product quality by adding new features and functionality. Otherwise they wouldn't be able to induce additional and new purchases. Therefore, software innovation and competition in software markets is mainly characterized by a steady addition and integration of new features within existing software products. For example, spell checkers were once a separate product category, but spell-checking is now simply a feature of word processors. As to OSs, there has been as well a steady enlargement of functions, e.g. the integration of audio-, video-, telecommunication-, and internet software.

(6) Path dependence theory can't be confirmed by empirical evidence and should not serve as a general framework for antitrust in high-technology markets. A very simple but powerful and realistic theoretical foundation of standard rivalry in markets subject to increasing returns to scale and their contestability by better product quality has been presented by LIEBOWITZ & MARGOLIS.[51] In contrast to ARTHUR, the model is constructed to provide independent consideration of the impacts of synchronization effects and production cost economies and diseconomies. While demand side synchronization effects favour the domination of a single standard this condition is not sufficient to guarantee such a result due to e.g. diseconomies of scale in production. Buyer heterogeneity and strong differences in tastes can lead to a co-existence of standards even in an environment of strong increasing returns to scale. Inferior lock-in solutions are a very unlikely result and a unstable market solution and can be overcome very easily. Markets are efficient since 'selection processes' are driven by product quality and not by chance.

6.3 Conclusion on the Applications Barrier to Entry

Empirical evidence has shown that Microsoft isn't an inferior lock-in monopoly from consumers' point of view. The market for OSs seems to be contestable in the long-run as well as in the short-run. Microsoft has only a temporary monopoly in the OSs market. It seems that Microsoft gained its dominant market position by better product quality and will only keep its position by providing better quality than its competitors. Application software is critical for success in the OSs market but the so-called applications barrier to entry can be eroded by providing better product quality. Network effects are responsible for Microsoft's dominant market position but are not in position to protect Microsoft against newcomers.

[51] See LIEBOWITZ & MARGOLIS (1996), pp. 1-23.

7. Assessment of the Judge's Argument on Monopolization of the OS Market By Anti-Competitive Actions (Violation of Section 2 of the Sherman Act)

7.1 Microsoft's Monopoly Power

The court justified Microsoft's monopoly power by the applications barrier to entry, its large and stable market share and by its pricing behaviour. However, there are three main problems regarding the District Court's argumentation.

First, as mentioned in the previous paragraph, application software is the key to success in the OS market but there's no resistant barrier to entry which can't be overcome.

Second, market definition in software markets is problematic because products tend to add features and functionality over time. Plaintiffs prefer very narrow market definitions like the argument that Internet browser software and OSs can be viewed as different products. In contrast, defendants will prefer a very broad product definition including future market conditions implying a market definition which goes beyond actual features like the statement that OSs and Browsers can't be viewed as distinct products since Internet Explorer has become an irreplaceable part of an OS in the Internet era. As a result, high market shares have got a less predictive quality in assessing monopoly power.

Third, the court argued that Microsoft maximized long-run profits by charging a price below the COURNOT price in order to make Windows more attractive and thereby generating more network effects, locking-in consumers and making entry more difficult for newcomers due to an increase in the applications barrier to entry. However, Microsoft already enjoys dominant positions in almost all markets where it competes so that there is no need to keep on expanding. If the court and plaintiffs were right that Microsoft possesses market power, it would be irrational to exercise a low-price-strategy since it is more profitable to exercise market power by increasing price, i.e. short-run profit maximization, than by raising non-price costs of rivals. Calculations by economists came to the result that the monopoly price of Windows amounts to roughly 800 US-$ whereas Microsoft sets an actual price of 60 US-$ per copy despite of a near monopolistic position. A more realistic explanation for Microsoft's pricing strategy is that Microsoft has chosen such a low price of Windows to make self-supply by other competitors unprofitable. Calculations came to the result that potential newcomers could earn a profit *before* development costs of 9 billion US-$ by selling an alternative to Windows despite of a price of 60 US-$ for a Windows copy. As a result, Microsoft believes that the development of a serious rival to Windows, including coding a new OS of the complexity of Windows, promoting it and inducing application sellers to develop compatible versions, costs 9 billion US-$. If Microsoft set the monopoly price of 800 US-$, development costs, or the applications barrier to entry of 9 billion US-$, could be easily overcome by rivals.[52]

These examples show that Microsoft's monopoly power isn't as strong as maintained by the District Court. It is possible to conclude alternatively that there is effective virtual competition in the market for OSs and that Microsoft doesn't possess monopoly power at all. It seems that Microsoft's pricing strategy aims at preventing rivals from entry and not at maximizing long-run profits. It could be argued that virtual competition brought down the price of Windows to a small fraction of its monopoly price and that social waste of duplicative investment in more OS is avoided as well. A more general problem for antitrust in network markets is the fact that monopoly may maximize social surplus when there are network effects present under conditions of incompatibility, so that de-facto standardization is a valuable outcome.

[52] See HALL & HALL (2000), p. 188-189.

7.2 Microsoft's Anti-Competitive Conduct

The court argued that Microsoft maintained its monopoly power by anti-competitive means by attempting to kill Netscape's Navigator and Sun's Java technology through predatory actions since (1) Navigator and Java are available for many OSs and (2) Navigator and Java could have become an efficient middleware technology and would have been able to attract important applications which would have resulted in a threat to Window's monopoly by weakening the applications barrier to entry.

The first problem with the court's argumentation is that Internet Explorer is also able to be compatible with many OSs and could also become a platform for OS-independent application software.

Second, for most users Netscape appears as being just a simple browser software and not as an alternative OS. Furthermore, Netscape isn't able to reach full functionality of a common OS since it is limited to Internet-based applications.[53]

Third, Netscape and Java have a very large installed base of users being not as large as Windows but far larger than Macintosh. As a result, the existing installed base could be an incentive for software developers to write programs for Netscape or Java. However, there have been written only very few applications. The main reason is that applications written for middleware technology run far slowly than under a common OS. For example, Corel tried to launch a version of WordPerfect in Java but didn't succeed since users claimed that it worked too slowly.[54]

Fourth, Microsoft's actions against Netscape and Java could be interpreted as aggressive competitive behaviour since Microsoft's version of Java was more efficient and much faster than Sun's non-OS-specific version.[55] Generally, and especially in the Microsoft case, since economies of scale and network effects easily lead to monopolistic industry structures, the line between aggressive competition and predatory conduct in the information economy is none too bright. It is not illegal to have a monopoly, only to monopolize or the attempt to monopolize. If a company obtains its monopoly position with fair conduct, i.e. with better product quality and lower prices than competitors, this company will be free to reap the benefits that come with market dominance. But even if this company obtained its monopoly position legally, it can and likely will be accused of defending or maintaining its dominant position through anti-competitive means since victory in the information economy, with its 'winner-take-all' outcomes inevitably generates ill will among the 'loser-gets-nothing' fraction. Furthermore, consumers, too, will complain that they are locked-in to a certain technology and that there would be better alternatives. If there can be only one 'natural' survivor in a market, the incumbent market leader has only two options, either excluding his competitors or being driven out of the market. Any strategy that does not exclude competition will not result in survival. There's no clear dividing line for a test of predatory conduct. The intent to exclude can be interpreted as the intent to survive in a 'winner-take-all' or 'winner-take-most' market.

8. Assessment of the Judge's Argument on the Attempt to Monopolize the Browser Market (Violation of Section 2 of the Sherman Act)

The court argued that Microsoft had tried to leverage its monopoly power in the OS market into the browser market in order to oust Netscape and to become the market leader for Internet browser software by integration of Internet Explorer within Windows. But for all Microsoft's very expensive efforts, Microsoft failed the attempt.

[53] See also ECONOMIDES (2001), p. 6.
[54] See LIEBOWITZ (2001), p. 3.
[55] See ECONOMIDES (2001), p. 7.

In general, the courts' rationale behind an accusation due to attempted monopolization by leveraging monopoly power into adjacent markets is that two monopolies are considered better than one and that such strategies will increase firm's profits and enlarge deadweight losses. But the *Chicago critique* argues that no one can extract monopoly surplus twice. When two goods are used together in fixed proportions it is clear that a monopoly on one is just as good as a monopoly on both, if the second market would be competitive if it weren't monopolized. As to this argumentation, Microsoft cannot be blamed for monopolization of the browser market because an additional monopoly in the browser market is of no use for Microsoft from a profit perspective.

Furthermore, the court contradicted itself with the definition of the browser and the OS market. On the one hand side, browser and OS are considered as different products as to the violation of Section 2, but on the other hand, the court argues that browsers can be interpreted as OSs according to the middleware argument; in this case, Microsoft can't be blamed for monopolization of the browser market since OS and browser market are the same.[56]

9. Assessment of the Judge's Argument on Tying Internet Explorer and Windows (Violation of Section 1 of the Sherman Act)

The court argued that tying of Internet Explorer hurt private consumers by creating confusion and frustration, by restricting the available choice of browser software and by imposing extra costs of installing Netscape. Business customers were hurt by increasing technical support costs. Further, Microsoft stifled the innovation process because it burdens the OS with memory and overhead requirement. Without Microsoft's conduct, there would have been more innovation.

All the allegations concerning consumer harm and impediment of innovation processes are hard to prove and seem to be exaggerated and trivial at some points. If one considers empirical evidence on Microsoft's pricing behaviour it could be argued that the court failed to demonstrate Microsoft's overall impact on consumers since there was no examination taking into account e.g. declines in prices after Microsoft became market leader.

As mentioned above, there's no clear line of argumentation if browser software and OSs can be viewed as being in separate markets or in the same market. Violation of Section 2, i.e. monopolization of the OS market, implies that browsers are in the same market as OSs (middleware argument) whereas violation of Section 1 and violation of Section 2, i.e. tying of Internet Explorer and the attempt to monopolize the browser market, imply that browsers and OSs are in different markets.[57]

As a result, market definition in software markets is very important in connection with allegations concerning tying and predatory actions. Undoubtedly, it is a clear violation of Sherman Act if a company with monopoly power in a certain market compels customers to buy an additional product of an adjacent market. But when WordPerfect added a spell-checker or WinWord a formula editor, a lot of customers considered this kind of 'tying' as an improvement in quality and not as predatory bundling. It is also questionable if WordPerfect engaged in anti-competitive conduct by giving away a spell-checker for free; one could also argue that WordPerfect was threatening producers of spell-checkers that might be potential newcomers in the market for word processing software. Just as well, adding new features and functionality can also be interpreted as a common competitive action in order to earn profits. Therefore, in software markets where product specification varies very quickly over time, market definitions which act in a rigid way don't seem to be very reasonable in order to obtain a social desirable outcome.

[56] See also ECONOMIDES (2001), p. 7.
[57] See also ECONOMIDES (2001), p. 8.

10. Assessment of the Proposed Remedy: Break Up into 'AppsCo' and 'OpsCo'

10.1 Does a Break Up Succeed?

The court stated that a break up of Microsoft reduced incentives for vertical foreclosure, the applications barrier to entry and restored lost competitive conditions; two separate Microsoft parts would allow other companies to compete effectively against Microsoft and 'AppsCo' might develop an alternative OS on the basis of Microsoft Office.

However, the proposed break up is unlikely to remove Microsoft's monopoly. The court claims that e.g. if Microsoft Office was ported to another OS such as Linux, then Linux would be able to overcome the applications barrier to entry. The judge also states that it takes thousands of applications to overcome the applications barrier to entry. As a result, porting Microsoft Office, consisting of only six applications, to alternative OSs won't be able to erode the applications barrier to entry. For example, Microsoft Office is already available for the Mac OS and there's a total amount of 10,000 to 15,000 applications available for Mac, yet the judge claims that Mac isn't a viable competitor. The fact that the judge claims that the proposed breakup might make e.g. Linux a viable competitor indicates inconsistencies within the judge's arguments.[58]

As to the middleware argument, a breakup is supposed to put Microsoft Office in place to become an alternative OS being able to compete with Windows and that Internet Explorer might become an OS independent middleware tool and that other middleware technologies could provide an alternative platform for Windows. However, Microsoft Office was never designed for OS functions and there are no signs that Office will support OS functions in the future. The same is true for Internet Explorer having never been conceived as a middleware tool and Netscape's Navigator was first and foremost developed as a browser and not as an OS being limited to Internet-based applications anyway. Consequently, there's no indication that the proposed remedy will end Microsoft's alleged unlawful behaviour and erode the applications barrier to entry.

Furthermore, a breakup would result in a general price increase of Microsoft's products. There are three reasons generating higher prices. First, the court concluded that Microsoft priced its OS deliberately low to expand its monopoly power in the adjacent browser market. Now, since there is no longer a possibility to exercise monopoly power in the browser market, Microsoft could rise the price of Windows.[59] Second, if the judge is correct and Microsoft loses significant monopoly power due to a breakup reducing the applications barrier to entry, Microsoft now has to maximize short-run profits by raising prices as long as there are no potential competitors. Third, price increases driven by raising costs will be the result from Microsoft no longer being able to exhaust economies of scale, learning and synergy effects in the joint production of Windows and Microsoft Office (economies of scope).

Consumers would be hurt due to a devastation of network effects since a breakup would result in new incompatibilities and therefore in higher costs for consumers.

Summing up, a break up would be an action against natural market forces like economies of scale and network effects which lead inevitably to a monopolistic market outcome. Furthermore, the court has not performed an appropriate cost-benefit analysis to show that other possible remedies would lead to an inferior result. Only if other possible remedies led to a worse outcome, a break up would be justified.

[58] See LIEBOWITZ (2001), p. 4.
[59] See also ECONOMIDES (2001), p. 10.

10.2 Other Possible Remedies

At the outset, the first question is if Microsoft violated the antitrust law at all. Empirical evidence by LIEBOWITZ & MARGOLIS makes one suppose that there's virtual competition in the market for OSs and that Microsoft's strategy is to prevent newcomers from entry by setting low prices and providing better product quality. Microsoft's actions against Netscape and Java can also be interpreted as aggressive competitive behaviour and not as predatory conduct. Providing better product quality by adding features and functionality seems to be an usual competitive mean. But as mentioned above, there's no clear frontier between competitive and predatory actions in 'winner-take-all' markets and the 'loser-gets-nothing' fraction has very strong incentives to blame the 'winner' for so-called anti-competitive actions. From there, one possible remedy would be to do nothing in order not to hamper the natural dynamic market forces in markets subject to serial and temporary monopolies.

Even if one comes to the conclusion that Microsoft engaged in predatory conduct there's also evidence that doing nothing can be a social optimal result. BECKER & MURPHY argue that even if there are anti-competitive actions like e.g. price dumping which harm competitors, these actions do not harm consumers. Empirical evidence has shown that every trial to prevent anti-competitive actions has resulted in actions which hampered competition. So, even if there are aggressive competitive strategies it is safe to assume that consumers benefit from these actions.[60]

In case Microsoft can be blamed for engaging in anti-competitive actions, other possible remedies could be e.g.:[61]

(1) *Restrictions on contracts*. The imposition of various restrictions on contracts Microsoft can sign with OEMs, ISPs and competitors would be very easy to enforce and would meet best the alleged violations. For example, Microsoft could be forbidden to restrict OEMs in their software choice of pre-installing.

(2) *Disclosure of relevant API information*. In order to solve the bundling and the middleware problem, Microsoft could be forced to disclose APIs which are responsible for the integration of Internet Explorer within Windows. If these APIs were accessible freely, each browser could be integrated into Windows and become perhaps a new platform of OS independent applications. Further, nobody could blame Microsoft for anti-competitive bundling.

(3) *Regulation*. The traditional solution to react to monopolies is regulation. But regulation makes only sense when the monopoly is unlikely to be eroded by entry or technological change. Software markets don't meet this requirement in general. Empirical evidence has shown that regulation can be more inefficient than a resistant monopoly. Furthermore, regulation requires a stable product. Software with its features being subject to a steady change would not meet this requirement. Furthermore, ECONOMIDES (2001) shows that in comparison with the AT&T case, regulation of Microsoft would be more restrictive since regulation of AT&T occurred only after a long time of AT&T's anti-competitive conduct. AT&T took much more aggressive actions than Microsoft, including the refusal to deal and the refusal to interconnect local telecommunication companies with AT&T's long distance network where it enjoyed a monopoly.

Summing up, there's no clear evidence that Microsoft engaged in anti-competitive conduct. But if competition in software markets should become less aggressive, the best remedy would be an imposition on contractual arrangements which do not discriminate Microsoft's competitors. A disclosure of APIs and regulation would be interventions which

[60] See BECKER & MURPHY (2001), p. 14.
[61] See also ECONOMIDES (2001), p. 12-14.

do not fit into a dynamic market where competition actually takes place and serial monopolies are a common phenomenon due to natural market forces.

11. Conclusion on the District Court's Decision

If Microsoft was broke up, competition policy would lock-in to an inferior historical time path due to an early arbitrary decision on Microsoft, since the probability that Microsoft engaged in predatory conduct or in lawful competitive actions amounts in each case to 50%. A break up would be a remedy against natural market forces. Since there are many firms having dominant market positions in the computer sector, e.g. Yahoo, AOL, etc., antitrust lawsuits driven by 'loser-gets-nothing' fractions would follow the Microsoft case.

Antitrust policy should not equate dominant market positions due to natural market forces with a risk in being locked-in to a resistant monopoly. In most cases, a punishment of market dominance is a punishment of very successful companies. Especially in software markets where technological change is very rapid, dominant market positions will be eroded very quickly if the incumbent does not provide the better alternative. From there, Microsoft's dominant market position is not due to unlawful conduct but due to superior economic performance.

Tests for monopoly power should not be orientated by pricing and actual market shares but more by contestability. In the information economy, prices are well above marginal costs (being equal to zero) since companies have to charge prices being higher than marginal costs in order to cover fixed investments costs. Market shares of 80% or more seem to be a direct result from increasing returns to scale and can't be used as an indicator of monopoly power. Furthermore, market definition should pay attention to the fact that competition in software markets is characterized by adding new features which could be easily understood as predatory bundling.

Antitrust remedies should refrain from structural interventions in markets or companies in order to influence the overall economic performance. Empirical evidence shows that structural remedies stifle innovation and hurt consumers by increasing costs and preventing workable competition. Antitrust policy should be orientated according to the principle *"competition policy is intended to ensure a fair fight, not to punish winners or to protect losers."*[62]

[62] See SHAPIRO & VARIAN (1999), p. 301.

PART II. ANALYSIS OF THE APPEALS COURT'S DECISION ON JUNE 28, 2001 AND THE PROPOSED SETTLEMENT BETWEEN THE DEPARTMENT OF JUSTICE AND MICROSOFT ON NOVEMBER 8, 2001

CHAPTER IV. ASSESSMENT OF THE APPEALS COURT'S DECISION[63]

12. Analysis of the Appeals Court's Decision

12.1 Overview

On June 7, 2000, Microsoft appealed from the District Court's decision. On June 28, 2001 the Washington D.C. Court of Appeals ruled on the appeal by Microsoft. The Appeals Court affirmed, revised and remanded parts of the District Court's decisions.

The Court of Appeals *affirmed* the District Court's conclusion that Microsoft violated Section 2 of the Sherman Act by monopolization of the OS market for PCs. The court is also of the opinion that Microsoft engaged in a variety of exclusionary contracts in order to protect its monopoly from the middleware threat.

The Appeals Court *reversed* the District Court's conclusion that Microsoft had tried to monopolize the Internet browser market in violation of Section 2 of the Sherman Act.

The Appeals Court *reversed and remanded* the District Court's conclusion that Microsoft had violated Section 1 of the Sherman Act by bundling Internet Explorer with Windows. The District Court was instructed by the Court of Appeals to investigate bundling of Internet Explorer to Windows under a 'rule of reason'[64] approach, i.e. the District Court has to weigh the positive effects for consumers against the negative effects owing to Microsoft's anti-competitive behaviour in order to determine the net effect on competition and on social welfare.

The Appeals Court vacated the District Court's Final Judgement and therefore all remedies including the breakup into two separate companies. The reasons were a lack of an evidentiary hearing on remedies and the fact that the District Court based its decisions on liability determinations which haven't been shared by the Appeals Court. The case was remanded to the District Court for new remedy proceedings.

District Court judge THOMAS PENFIELD JACKSON was expelled from the case retroactively to the date of entry of the Final Judgement due to improper behaviour during the lawsuit.

12.2 Accusation: Microsoft Violated Section 2 of the Sherman Act Through Monopolization of the OS Market for PCs by Anticompetitive Actions

The court concludes that Microsoft has monopolized the OS market for PCs on the grounds that Netscape would have been able to become an alternative cross-OS middleware platform being able to reduce the applications barrier to entry. The court also states that Netscape only had a little chance to reduce Microsoft's market power but that several actions taken by

[63] This part is based on U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), pp. 1-125.

[64] Generally, Section 1 of the Sherman Act is interpreted as making illegal *'per se'* all arrangements among enterprises aiming at fixing prices and output and all actions restricting the force of competition. In order to prove a violation under a *'per se'* rule, the plaintiff only has to show that some conduct occurred that can be subsumed under the class of plainly anticompetitive actions. There is no detailed investigation of the defendant's economic rationale and the economic consequences of his anticompetitive behaviour. In contrast to this *'per se'* approach, a *'rule of reason'* approach requires a detailed investigation of the defendant's practices, the motivation why they were implemented, their effects on consumers, competitors and on social welfare.

Microsoft in order to hinder Navigator's spreading were anticompetitive in the sense of Section 2 Sherman Act. However, in contrast to the District Court's decision, Microsoft is found not guilty of having violated Section 2 Sherman Act separately by its general 'course of conduct'.[65]

In order to find monopolization of the PC OS market by Microsoft, the Court of Appeals has – in accordance with the current interpretation of Section 2 Sherman Act – to prove (1) that Microsoft possesses monopoly power in the relevant market being protected by substantial barriers to entry and (2) that Microsoft wilfully acquired or maintained its monopoly power by the use of anti-competitive conduct to hamper competition.

12.2.1 Microsoft's Monopoly Power in the OS Market Protected by the Applications Barrier to Entry

Concerning the assessment of Microsoft's monopoly power, the Court of Appeals follows the District Court's argumentation. The two factors indicating Microsoft's monopoly power are (1) Microsoft's large and stable market share and (2) the 'applications barrier to entry'.

12.2.1.1 Microsoft's Market Share

The Appeals Court also argues that since the last decade Microsoft enjoyed a permanent market share of greater than 95% in the market for OSs for Intel-compatible PCs and a market share of about 80% if one includes the Macintosh OS.[66]

12.2.1.2 The 'Applications Barrier to Entry'

Just as the District Court, the Appeals Court states that the applications barrier to entry stems from two characteristics in software markets,

> *"…(1) most consumers prefer operating systems for which a large number of applications have already been written [network effects]; and (2) most developers prefer to write for operating systems that already have a substantial consumer base [economies of scale]. See Findings of Fact ¶¶30,36. This 'chicken-and-egg' situation ensures that applications will continue to be written for the already dominant Windows, which in turn ensures that consumers will continue to prefer it over other operating systems."*[67]

In the same way, the Appeals Court uses the empirical OS/2 example to show that the OS market is characterized by a 'winner-take-all' and 'loser-gets-nothing' solution and that network effects protect Microsoft's dominant position. Middleware software is also thought of not being able to

> *"…expose a sufficient number of APIs to erode the applications barrier to entry in the foreseeable future."*[68]

In line with the District Court's decision, the connection with path dependence theory comes with the argument that

> *"[i]t is certainly true that Windows may have gained its initial dominance in the operating system market competitively – through superior foresight or quality. But this case is not about Microsoft's initial acquisition of monopoly power [the court is not convinced that economic efficiency exclusively led to Microsoft's dominant position and that there could have been other factors – like early luck -*

[65] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 59.
[66] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 19-20.
[67] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p.20.
[68] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 22.

having been responsible for Microsoft's success but doesn't make any statement on the technology selection problem]. It is about Microsoft's efforts to maintain this position through means other than competition on the merits [i.e. the court reduces the analysis only to the question if Microsoft can be considered as an inefficient lock-in monopoly today]…"[69]

but

"[b]ecause the applications barrier to entry protects a dominant operating system irrespective of quality, it gives Microsoft power to stave off even superior new rivals. The barrier is thus characteristic of the operating system market, not of Microsoft's popularity, or, as asserted by a Microsoft witness, the company's efficiency."[70]

As in the District Court's decision, Microsoft is not *explicitly* blamed for having been an inferior solution *in the past*. However, Microsoft is *implicitly* blamed for being an *inferior lock-in standard today* who gained its dominant market position in the past by *positive feedback* and who is protected by the applications barrier to entry. Though the Appeals Court mentions explicitly the controversial debate

"…over the extent to which old economy §2 monopolization doctrines should apply to firms competing in dynamic technological markets characterized by network effects."[71]

and the possibility that SCHUMPETERIAN quality competition in markets subject to rapid technological progress suggests

"…that the economic consequences of network effects and technological dynamism act to offset one another, thereby making it difficult to formulate categorical antitrust rules absent a particularized analysis of a given market…"[72]

the Appeals Court rules in accordance with the District Court's analysis of Microsoft's market power in the relevant market due to the intractable 'chicken-and-egg' problem.[73] That is, the Court of Appeals also accepts the 'ARTHURNOMICS-Lock-In' paradigm stating that Microsoft's dominant market position is protected by network effects.

12.2.2 Conclusion on Microsoft's Market Power

Summing up, the Appeals Court economic perspective is also built on parts of path dependence theory despite the fact that path dependence theory is lacking in empirical evidence. The abrogation of the breakup remedy and the decision to maintain the 'applications barrier to entry' theory are a contradiction in terms: an insurmountable barrier to entry due to network effects would mean that Microsoft's inefficient lock-in position could only be abandoned by a destruction of the 'chicken-and-egg'-cycle, e.g. by a breakup, which would restore lost competition as shown in chapter 5.4. From this 'lock-in-perspective', the Appeals Court has helped Microsoft to strengthen its dominant position; imposing conduct restrictions isn't useful at all for restoring lost competition in a lock-in market since restrictions on future contracts won't destroy existing network effects and won't provide the basis for the evolution of viable alternatives to Windows. Still, if conduct restrictions are in fact a useful mean in restoring lost competition, the underlying economic lock-in paradigm has to be wrong and should be modified by the Court of Appeals as it was recommended in previous paragraphs. A correct economic paradigm should weigh the effect of network effects

[69] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 22.
[70] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p.22.
[71] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 11.
[72] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p.12-13.
[73] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 20.

and economies of scale leading to monopolistic outcomes and the counteracting effect of technological progress and base the decision on the net effect.

12.2.3 Microsoft's Anticompetitve Conduct[74]

Like the District Court, the Court of Appeals finds that Microsoft committed a number of anti-competitive acts in order to preserve its monopoly being punishable under Sherman Act Section 2:

(1) Microsoft issued restricted licenses to OEMs making it difficult or impossible to include alternative Internet browsers.
(2) Microsoft integrated its browser Internet Explorer within Windows without any possibility to remove it thereby excluding alternative browser software.
(3) Microsoft engaged in exclusive arrangements with IAPs, ISVs and Apple to promote Internet Explorer and not to distribute Netscape
(4) Microsoft misled Java developers in order to protect the applications barrier to entry since Microsoft included in its Java version some functions which could only be executed by Microsoft's Java.

12.3 Acquittal: Microsoft Didn't Violate Section 2 of Sherman Act by Attempting to Monopolize the Browser Market[75]

The Appeals Court finds that Microsoft didn't attempt to monopolize the Internet browser market due to the following reasons:

(1) Plaintiffs weren't able to provide a consistent market definition of the browser market.
(2) Plaintiffs failed to demonstrate that there were significant barriers to entry for rivals.
(3) Plaintiffs failed to show that Microsoft was likely to erect significant barriers to entry after gaining a dominant market share.

12.4 New Investigation of Tying by a *Rule of Reason* Approach: Microsoft Didn't Violate Section 1 of the Sherman Act *Per Se* by Tying Internet Explorer with Windows[76]

The Court of Appeals concludes that a per se reasoning is inappropriate for the tying argument since

> *"[a]pplying per se analysis to such amalgamations creates undue risks of error and of deterring welfare-enhancing innovation."*[77]

The court orders that the tying claim has to be examined under a 'rule of reason' approach by the lower court because

> *"[w]e merely note that these and other novel, purported efficiencies suggest that judicial "experience" provides little basis for believing that, " because of their pernicious effect on competition and lack of any redeeming virtue," a software firm's decisions to sell multiple functionalities as a package should be "conclusively presumed to be unreasonable and therefore illegal without elaborate inquiry as to the precise harm they have caused or the business excuse for their use.""*[78]

[74] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 25-58.
[75] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 62-68.
[76] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 68-90.
[77] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 77-78.
[78] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 79.

Under this 'rule of reason' approach, the plaintiffs have to prove that the negative impact of the tying act was larger than any positive effects on consumer utility and on competition.

12.5 Abrogation: The Proposed Breakup Remedy and Conduct Restrictions are Vacated[79]

The Court of Appeals vacates the District Court's proposed remedy (illustrated in section 4) on the basis of three reasons:

(1) The District Court failed to hold an evidentiary hearing despite of remedies-specific factual disputes.

(2) The District Court didn't provide adequate explanation for the imposition of the proposed remedies.

(3) Since the Appeals Court reduced the scope of Microsoft's liability considerably (Microsoft is only blamed for having monopolized the OS market), the District Court was instructed to determine a different remedy which meets the altered accusations better since

> *" (…) the District Court determined that the conduct restrictions and the pervasive structural remedy were together appropriate to remedy the three antitrust violations [tying Section 1, attempted monopolization of browser market Section 2, monopolization of OS market Section 2] set forth above. The court did not exercise its discretion to determine whether all, or for that matter, any, of those equitable remedies were required to rectify a § 2 monopoly maintenance violation taken alone. We therefore cannot sustain an exercise of discretion not yet made."*[80]

In order to find an appropriate remedy, the Appeals Court instructs the lower court to take into account the following points:

(1) The District Court has to consider the problems a breakup would cause because
"[i]f indeed Microsoft is a unitary company, division might very well require Microsoft to reproduce each of these departments in each new entity rather than simply allocate the differing departments among them". [81]

(2) The District Court has to check if there is a sufficient causal connection between Microsoft's dominant market position and its anticompetitive conduct because
"[m]ere existence of an exclusionary act does not itself justify full feasible relief against the monopolist to create maximum competition"[82]
which indicates that
"[r]ather, structural relief, which is "designed to eliminate the monopoly altogether (…) require[s] a clearer indication of a significant causal connection between the conduct and creation or maintenance of the market power.""[83]
Thus, the Appeals Court notes that
"[i]f the court on remand is unconvinced of the causal connection between Microsoft's exclusionary conduct and the company's position in the OS market, it may well conclude that divestiture is not an appropriate remedy."[84]

[79] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 90-106.
[80] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 101.
[81] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 105.
[82] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 105.
[83] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 105.
[84] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p.105-106.

12.6 Improper Judicial Behaviour by Judge THOMAS PENFIELD JACKSON[85]

The Court of Appeals finds that District Court judge THOMAS PENFIELD JACKSON violated codes for U.S. judges which forbid to make public comments on lawsuits by giving comments to reporters on the Microsoft case. The Appeals Court states that all

"[t]he violations were deliberate, repeated, egregious, and flagrant."[86]

On the basis of JACKSON's violations, the Appeals Court assigned the case to District Court Judge COLLEEN KOLLAR-KOTELLY and released JACKSON from the moment he ordered Microsoft's breakup.

13. Conclusion on the Appeals Court's Decision

The Appeals Court's decision can be viewed as an appropriate ruling in accordance with the critical assessment of the District Court's decision in chapter III but is based as well on ARTHUR's questionable 'lock-in' paradigm.

The Appeals Court's judgement meets the alleged violations better than the District Court's Final Judgement and is going to improve social welfare. Further, it can be interpreted as a major victory for Microsoft since (1) the breakup is quashed, (2) Microsoft is found innocent in important points, and (3) it is very unlikely that the next remedy will be a breakup of the company.

However, the court's ruling and its underlying economic paradigm are not consistent. The court's judgement would suggest that its decisions are based on an 'efficient SCHUMPETERIAN market view' where market definitions are not dynamically stable due to rapid technological change. Even though the Appeals Court is dealing very intensively with the problematic nature of assessing the strength of barriers to entry in markets subject to network effects and the counteracting force of technological progress, the court holds on the one-sided argument that network effects are responsible for the evolution of resistant 'winner-take-all' or 'winner-take-most' markets which are considered not to be contestable in the long run. The 'lock-in' paradigm stating that high technology markets tend to end in a market failure can be viewed as a danger for future antitrust decisions in network markets. If U.S. antitrust law bases its future decisions in 'new economy' markets on 'lock-in' theories which are lacking in overall empirical evidence, U.S. antitrust policy will be locked-in a inefficient historical time path since a lot of markets in the 'new economy' are characterized by high seller concentration and would – in accordance with 'lock-in' theories - need therefore a radical antitrust supervision and intervention causing investor uncertainty and a threat to future economic growth.

CHAPTER V. SETTLEMENT BETWEEN THE DEPARTMENT OF JUSTICE AND MICROSOFT ON NOVEMBER 8, 2001

14. The District Court's Procedure Upon Remand

After the case was remanded to the District Court for further proceedings, the District Court ordered the plaintiffs and Microsoft to elaborate jointly a status quo report which was supposed to contain the issues to remain on further remand, the proposed remedies and a timetable for the subsequent procedure. The plaintiffs agreed upon not claiming any longer a violation of Section 1 Sherman Act by Microsoft and decided not to demand a breakup of the company.

[85] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p. 106-125.
[86] See U.S. COURT OF APPEALS FOR THE DISTRICT OF COLUMBIA CIRCUIT (2001), p.106.

After the parties had filed their joint status quo report, the District Court ordered them to reach an efficient and fair solution in settlement negotiations beginning on September 28, 2001. The United States and Microsoft filed their proposed Final Judgement on November 2, 2001. After further negotiations, on November 6, 2001 Illinois, Kentucky, Louisiana, Maryland, Michigan, New York, North Carolina and Wisconsin settled as well on the proposed Final Judgement. The States of California, Connecticut, Florida, Iowa, Kansas, Massachusetts, Minnesota, Utah and West Virginia didn't join in the proposed Final Judgement.[87]

15. The 'Proposed Final Judgement' and its Competitive Impact

According to the District Court, the 'Proposed Final Judgement'

> *"… will provide a prompt, certain and effective remedy for consumers by imposing injunctive relief to halt continuance and prevent reoccurrence of the violations of the Sherman Act by Microsoft that were upheld by the Court of Appeals and restore competitive conditions to the market. Entry of the Proposed Final Judgement will terminate this action, except that the Court will retain jurisdiction to construe, modify, or enforce its provisions and to punish violations thereof."*[88]

The Proposed Final Judgement consists of conduct provisions which can be viewed as an actual compromise since it contains rules for market behaviour which meet both plaintiffs' and Microsoft's interests.

Provisions which comply with plaintiffs' claims can be summarized as follows:[89]

(1) *Conduct Provisions towards Middleware Technology*. In order to provide an opportunity to overcome the 'applications barrier to entry', the Proposed Final Judgement plans to strengthen and to protect the development of middleware technology. Microsoft is required to disclose its APIs linking Microsoft middleware with the OS. As a result, there is an incentive for software developers to create middleware applications competing with Microsoft's integrated functions. There is also the possibility for alternative OSs (like Linux or Macintosh) to overcome Microsoft's dominant position by the development of OS-independent and middleware-compatible application software. In order to ensure that there is enough potential for new technologies to evolve, the Proposed Final Judgement chooses a broad definition of middleware products including browsers, media players, e-mail clients, instant messaging software and future new middleware developments. In order to enable consumers and computer manufacturers to use alternative middleware software effectively and not being compelled automatically to use the built-in Windows functions (like Internet Explorer in the past), it has to be guaranteed that there is a free choice to install or not to use the Windows product. This effect could be succeeded by including an add/remove function for middleware applications during the installation process of Windows.

(2) *Conduct Provisions Towards Server Software Competitors*. Microsoft is obliged to disclose relevant APIs guaranteeing the interoperation of common server software with Microsoft's PC software. In the past, only Microsoft's server software has been able to interoperate with PC Windows. As a result, Microsoft has been able to transfer its monopoly in the PC market on the server market. The disclosure will end the distortion

[87] See U.S. DEPARTMENT OF JUSTICE, ANTITRUST-DIVISION (2001b), p. 8-9.
[88] See U.S. DEPARTMENT OF JUSTICE, ANTITRUST-DIVISION (2001b), p. 2.
[89] See U.S. DEPARTMENT OF JUSTICE, ANTITRUST-DIVISION (2001b), p. 25-53 and U.S. DEPARTMENT OF JUSTICE (2001), pp. 1-3.

in the server software market and server support applications could (like middleware) overcome Microsoft's monopoly by creating OS-independent application software and thereby weakening the applications barrier to entry.

(3) *Conduct Provision Regarding Licence Agreements*. Microsoft is obligated to enter into uniform licence agreements with OEMs for the next five years and prohibited to differentiate among them. Microsoft is forbidden to retaliate against OEMs and software developers not supporting or developing Microsoft software. At the same time, Microsoft is prohibited from entering into contracts intending to provide exclusive support or development of Microsoft software. These provisions of entering into licence agreements with OEMs and software developers are supposed to (1) allow to enter into contracts with Microsoft and at the same time supporting competing products and (2) to use all the options provided by the Proposed Final Judgement effectively, i.e. with no fear of being discriminated by Microsoft.

In order to ensure that all conduct restrictions can be enforced effectively, the Proposed Final Judgement also contains several provisions concerning enforcement, compliance and duration:

(1) *Licensing of Microsoft's Intellectual Property*. Microsoft is required to make available and to licence all intellectual property OEMs and software developers need in order to exercise their rights they got by the Proposed Final Judgement.

(2) *Monitoring of Microsoft's Market Conduct*. There will be a panel of three full-time computer experts with full access to all Microsoft's books, systems, personnel and source code. One member will be appointed by Microsoft, one by the Department of Justice and one by both.

(3) *Duration*. All provisions will stay into force for five years with the possibility of a two-year prolongation if Microsoft is found guilty of having violated the Proposed Final Judgement.

From Microsoft's point of view, there are also some provisions which can be interpreted as being favourable for the company.

(1) *No Restrictions on Further Innovation and Bundling*. The decision not to blame Microsoft for having bundled Internet Explorer with Windows allows Microsoft to include every complementary software and every new functionality within Windows it wants to. This is a fair decision since software companies compete dynamically by inventing new products and adding new functions is critical for new sales (see section 6.2). The situation in the middleware and application software market can be interpreted as being very competitive since all firms now have a real chance to compete with their software on the Windows platform and no competitor can be excluded by Microsoft. If Microsoft products are really better than alternative ones, Microsoft possesses its monopoly justly, otherwise Microsoft will lose its dominant position.

(2) *No Complete Regulation and Intervention.* Microsoft isn't divided into two separate parts which would have caused a great damage to Microsoft's future development. The liability to disclose internal information of Windows is only limited to APIs of middleware and application software, a procedure Microsoft did permanently in the past (except the refusal to disclose the relevant APIs to Netscape). As a result, the Proposed Final Judgement can be interpreted as a remedy not destroying Microsoft's future development but strengthening competition between Microsoft and rival firms.

Summing up, the Proposed Final Judgement seems to contain a very efficient remedy concerning the improvement of social welfare which meets the alleged violations better than a breakup would have met (see the analysis in part I, chapter III). It can be considered as a fair settlement since both plaintiffs and Microsoft reached a solution which can be seen as favourable for each party. It seems also that the Department of Justice was able to obtain a better solution than it would have achieved in a full remedies trial. However, no final decision

has been achieved so far. The final result depends on whether the remaining States will join the Proposed Final Judgement or not.

16. Conclusion on the Microsoft Case

The Proposed Final Judgement can be viewed as a real improvement in social welfare and in competition conditions, provided that it will be accepted by the remaining Federal States. Past decisions have shown that structural interventions are not in a position to improve competition and social welfare. Future antitrust policy, especially in network markets, should refrain from fighting against natural market forces like economies of scale and network effects leading to dominant market positions. Antitrust policy has only to guarantee that relevant markets remain *contestable* by monitoring market conduct of the dominant firm.

However, the most difficult exercise is the assessment of contestability in network markets. High fixed investments, economies of scale and network effects can lead very quickly to dominant market positions which can be considered as inefficient lock-in solutions. But as empirical evidence has shown, the Microsoft 'chicken-and-egg' story which is supposed to lead to an inferior lock-in situation is not correct. Since the Appeals Court hasn't revised the 'applications barrier to entry' theory, there is a great danger of inducing a lot of antitrust lawsuits by 'loser-gets-nothing' fractions in the future claiming that they are locked-in to the 'inefficient' incumbent and that antitrust policy should intervene. If such a mentality is accepted in general by network market participants, there is a great threat to economic growth since investor uncertainty is going to prevent necessary investments in high technology sectors. As the VHS-DVD example has proved, there are reasonable opportunities to overcome a dominant market position of an established incompatible standard by providing better product quality, and the same is true for software markets. Network markets in the 'New Economy' are characterized by *serial temporary monopolies* due to SCHUMPETERIAN processes of *creative (quality-)destruction.* It is necessary that antitrust institutions realize that there is no real world evidence for lock-in stories like path dependence theory, otherwise 'New Economy Markets' are really going to be locked-in to an inefficient historical time path with low growth.

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