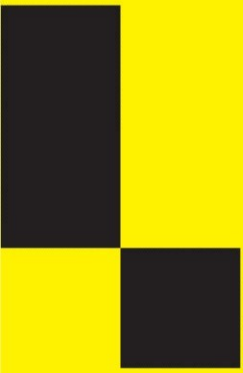
562 LECTURE NOTES IN ECONOMICS AND MATHEMATICAL SYSTEMS



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Standardization and Expectations

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ISSN 0075-8442
ISBN-10 3-540-28112-6 Springer Berlin Heidelberg New York
ISBN-13 978-3-540-28112-2 Springer Berlin Heidelberg New York

Springer is a part of Springer Science+Business Media

springeronline.com

Printed in Germany

Typesetting: Camera ready by author
Cover design: *Erich Kirchner*, Heidelberg

Printed on acid-free paper 42/3130Jö 5 4 3 2 1 0

Preface

This book has been accepted as my doctoral thesis by the Department of Economics at the University of Hamburg. First of all, I am indebted to my supervisor, Prof. Manfred Holler, for his scientific guidance and support. At his Institute of SocioEconomics, I have found an environment that was ideal for my research. I would also like to thank Prof. Hans-Joachim Hofmann and Prof. Wilhelm Pfähler for helpful comments.

I am also very grateful to Prof. Gunther Engelhardt for supporting me during my time as Teaching and Research Assistant at the Institute of Public Finance, University of Hamburg.

I have received valuable comments from a large number of people. I wish to thank in particular my colleagues Heide Coenen, Jörg Gröndahl and Ingolf Meyer Larsen for interesting and inspiring discussions.

Finally, I thank my parents and my brother for their encouragement and help.

Hamburg, September 2005 *Tobias Langenberg*

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1

Introduction

Over the last decades, technological progress has brought about a multitude of standardization problems. For instance, compatibility standards ensure the interoperability of goods, which is of decisive importance when users face positive externalities in consumption. These so-called "network externalities" refer to goods such as telephones or fax machines, which would generate only small benefits if they were adopted by few users. Such communication networks involve direct network effects in that the consumption benefit of a single user directly increases with the number of network participants. The existence of network externalities suggests that the allocation in network markets may be inefficient. Typically, the buyer of a network good takes into account his private costs and benefits without internalizing the network benefits he generates for other network participants. Thus, an important question in the economics of network effects and standardization is whether network markets bring about efficient standards.

Since the early contributions by David (1985), Farrell and Saloner (1985), Katz and Shapiro (1985), a vast literature on network effects and standardization has been evolving. But yet, little attention has been devoted to the formal analysis of how standardization and consumers' expectations interact. Expectations are of decisive importance of whether a new technology will prevail as de-facto standard or not. Early adopters must be confident that the network good will be successful. Thus, it may be worthwhile for firms to influence expectations. A classical tactic aimed at influencing expectations is product pre-announcement. By pre-announcing its upcoming technology, a firm may increase the expected network size of its new technology to the disadvantage of the rival's technology. For instance, in the mid 1980s, Borland released its

new spreadsheet Quatro Pro. However, its main rival Microsoft thwarted Quatro Pro's growth by pre-announcing (and praising) the next release of its competing software, Excel.[1]

Economides (1996a) discusses an alternative way to influence expectations. He shows that it can be worthwhile for an incumbent monopolist to share its technology with competitors. What drives this model result is the assumption that high expected sales increase consumers' willingness to pay for the network good. By inviting competitors into its network, the incumbent firm can credibly commit to a network size which exceeds its profit-maximizing monopoly quantity. Thus, the incumbent firm faces a tradeoff. On the one hand, the invitation of rival firms increases the equilibrium network size and thus consumers' willingness to pay via network effects. On the other hand, the invitation of rival firms involves competition. For a given level of expected sales, this "competition effect" has a negative impact on the incumbent's profit.

This type of expectation management can also be applied to the case of indirect network effects and systems competition.[2] Then, the supplier of a hardware-software system may invite independent suppliers of compatible software products, thereby committing credibly to a large variety of software. Alternatively, buyers would run the risk of facing a small variety of software in the future. Due to high switching costs, they might be "locked-in" to the corresponding hardware-software system.[3] IBM's strategy of licensing its technology to independent hardware and software manufacturers gives an example for successful expectation management to establish the PC standard. The rival Apple-Mac network followed another strategy. The first ten years after the introduction of the Mac, Apple refused to license independent manufacturers, so-called clones. As a consequence, Apple's market share constantly decreased.

Thus, numerous examples suggest that expectations are "a key factor in consumer decisions about whether or not to purchase a new technology,..."

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[1] See Farrell and Saloner (1986a) for a formal analysis of product pre-announcements.

[2] See Holler, Knieps and Niskanen (1997) for an overview of various models with network effects.

[3] See Klemperer (1987), Farrell and Shapiro (1988), Arthur (1989), Beggs and Klemperer (1992) and Witt (1997) for a discussion of consumer lock-in.

(Shapiro and Varian, 1999, p. 275). Consisting of three essays on various aspects of standardization and expectations[4], this thesis aims at deepening our understanding of how standards and expectations interact. The analysis puts an emphasis on the following main questions:

1. How may existing standards affect the agents' expectations?
2. How may expectations affect the evolution of standards?
3. What are the welfare implications of the equilibrium, and which solutions would be imposed by a "social planner"?

The main purpose of the first essay is to find economic reasons why university examinations should be standardized, *i.e.* why the requirements should be comparable among different universities. The essay refers to the main question of how standards may affect agents' (*i.e.* employees' and employers') expectations. Here, standardization is considered as a means of reducing variation in examination requirements. This kind of reference standard may be realized by introducing central examinations. Or alternatively, diplomas should qualify for accreditation by certification bodies.

Starting from the basic signaling model, taken from Spence (1973), the first essay analyzes the welfare implications of signaling. Whereas signaling is only a distributive device in the basic model, an extension of the model shows that signaling may increase total output by enabling correct matching of employees to jobs. If examination requirements vary among universities, the job-matching effect deteriorates. This situation of incomplete information about the signal's quality is formalized as a Bayesian Game. Employers and employees are assumed to know the distribution of examination requirements. On the basis of this common knowledge, employers form expectations about whether a signaling employee belongs to the more productive type or not. By standardizing the requirements, the educational signal regains reliability and recovers its job-matching function. However, there is a tradeoff between the job-matching function and total signaling costs.

The second essay analyzes the competition between two firms when their incompatible technologies exhibit network effects. We mainly refer to the

[4] The analysis is not confined to compatibility standards and network effects. In fact, it also deals with so-called reference standards, which facilitate the transaction of complex goods by describing product features. See 2.1, for a taxonomy of standards.

problem of how compatibility standards may affect consumers' expectations.[5] Our framework distinguishes between two different regimes of standardization. Whereas the first regime involves that firms compete within a joint network (*intra-technology competition*), the second regime refers to standardization by means of blockaded or deterred entry of a rival technology (*inter-technology competition*).

Following Economides (1996a), we assume that high expected sales increase the willingness to pay for the corresponding good. At the equilibrium level, consumers' expectations have to be fulfilled. Whereas the model by Economides is confined to intra-technology competition, we will analyze both intra-technology and inter-technology competition. An incumbent firm faces the strategic choice of whether to share its superior technology (via free licensing) with a follower or to keep its technology for itself. The first option of sponsoring intra-technology competition increases the incumbent firm's network and thus consumers' willingness to pay because the incumbent credibly commits to a larger network. On the other hand, the latter option involves inter-technology competition. Depending on the relative cost advantage of the incumbent firm, the entry of the rival technology may be blockaded, both technologies can coexist in an incompatible duopoly or the incumbent firm may deter the market entry of its rival. The essay investigates the incumbent firm's choice of whether to sponsor intra-technology competition or to insist on inter-technology competition.

The third essay deals with standardization of nascent technologies. A common characteristic of nascent technologies is that consumers cannot completely assess the product's quality at the time of market launch. We make the assumption that consumers learn about the actual stand-alone value of a technology after using it ("learning by using"). Before using the technology, consumers are assumed to know the distribution of stand-alone values, only. We will present a two-period framework with two competing network technologies and two consumers. In the first period, consumers may adopt incompatible technologies (*experimentation*), or they can choose a joint technology (*ex-ante standardization*). In the second period, the stand-alone values of all tech-

[5] However, the second essay also touches on the subject of how expectations may affect the evolution of standards. The incumbent's strategic choice between inter-technology and intra-technology competition involves multiple equilibria. Thus, consumers' expectations determine the evolution of standards.

nologies used in the first period become public knowledge. Based on this information, each user chooses among three options: Firstly, the user may stick to his technology. As a second option, he can switch to the other technology. Finally, the user may choose an "outside option".

Ex-ante standardization is related to consumers' expectations inasmuch as it involves *limited information* in the second period: Consumers only find out the actual stand-alone value of the joint technology which they have chosen as ex-ante standard. On the basis of the observed stand-alone value, consumers form expectations about the alternative technology (which they have not yet used), *i.e.* they revise the expected ex-ante value according to the Bayesian rule. Experimentation allows consumers to find out the actual stand-alone values of *both* technologies so that their choice of the ex-post standard is based on *complete information*. However, experimentation involves a transient or even persistent loss of compatibility. By means of ex-ante standardization, consumers enjoy network benefits from the beginning. Thus, there exists a tradeoff between ex-ante standardization and experimentation.

The third essay also refers to the second main question of how consumers' expectations affect the evolution of standards. Consumers' ex-ante expectations about the technologies' values are represented by the joint probability distribution, which is "common knowledge". We will analyze the impact of different parameters such as correlation, variance and expected values on the equilibrium values. For the sake of traceable results, we will assume that the values of two potential technologies are drawn from a bivariate normal distribution. The numerical analysis demonstrates that consumers prefer ex-ante standardization to experimentation if they expect the values of both technologies to be strongly correlated. Furthermore, the model shows that if the technologies are not equally attractive ex ante, there can be too much ex-ante standardization compared with the social optimum, or consumers may choose an inferior technology as ex-ante standard.

Table 1.1 shows a classification of the three essays with respect to the considered type of standard and the problem of how standards and expectations interact. Since each essay deals with the third main question of how a social planner should intervene, this problem is omitted in our classification. The structure of this thesis arises from the classification. Chapter 2 is devoted to a brief introduction to the concept of network effects and standardization, which