

# Bertrand Competition in Markets with Network Effects and Switching Costs\*

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November 2007 (Preliminary version)

## Abstract

In the paper we analyze duopoly competition at the market with network effects and switching costs. We find that the evolution of the firms' market shares depends on the single parameter which measures the relative importance of the switching costs coefficient compared to the network effects coefficient. Apart from the known dynamics of the firms' market shares in which the difference between the firms' market shares decreases in every period we also get "monotone monopoly outcome" and "alternative monopoly outcome" in which the difference between the firms' market shares increases in every period with the dominant firm keeping its position in the former case and losing in the latter. We find that for high switching costs there is the only stable and stationary equilibrium in which both firm share the market equally. For moderate network effects there are two stable and stationary equilibria in which one of the firms gains the whole market. And for very high network effects there are no stable and stationary equilibria. We also show that under moderate network effects the firm

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\*We thank Pio Baake, Justus Haucap, Paul Heidhues, Franz Hubert, Roman Inderst, Christian Schade as well as seminar participants at the Humboldt University Berlin and the workshop on "Industrial Organization and Antitrust Policy" (at DIW Berlin, 2007) for helpful comments. We gratefully acknowledge financial support by the Volkswagen Foundation for the research project "Innovation and Coordination".

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which has gained the “critical” value of the market share gains the whole market in the next period.

*Keywords:* Network Effects; Bertrand Competition; Switching Costs.

*JEL-Classification:* D43, L13

# 1 Long Abstract

Competition in many parts of modern economies, and in particular, in so-called high tech industries is increasingly characterized by technologies which give rise to pronounced network effects and by switching costs consumers have to forego when they change the technology (for a recent survey, see Farrell and Klemperer, 2006).<sup>1</sup> Technologies are typically either completely or at least partially incompatible, while product differentiation often plays only a minor role. Network effects and the associated installed base effects as well as consumer switching costs have also produced intense debates in competition policy circles concerning the appropriate application of traditional competition policy concepts (see. e.g., OECD, 1997, and FTC, 1996)

We observe strikingly different market dynamics when incompatible technologies compete against each other and network effects are an essential feature of the market. In many instances, competition between technologies leads to a persistent monopoly outcome where one technology becomes the de facto standard in the market while rival technologies are completely driven off the market. At the same time, we also observe market sharing outcomes, where incompatible standards compete head-to-head. Another characteristic of those markets concerns the dynamics towards the final market outcome which can be either monotone or alternating.

A famous case of a monotone monopolization process is the QWERTY standard (see David, 1985 and Arthur 1989). Monopolization was also the outcome in the VCR standards battle between VHS and Beta, where dominance alternated (for description of this case and the evolution of market shares, see Cusumano, Mylonadis, and Rosenbloom, 1992). While Beta benefited from a first-mover advantage and obtained a dominant position in the early seventies, VHS managed to displace Beta completely after a period of more than ten years. Similarly, market dominance altered in the famous rivalry between Apple's and Microsoft's operating systems.

A striking market sharing outcome between (partially) incompatible standards is documented in Augereau, Greenstein, and Rysman (2006) who study the adoption of 56K modems by internet service providers in the US in the late nineties. Similarly, the market for videogame consoles is shared between three major producers (in particular, Nintendo, Sony, and more recently,

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<sup>1</sup>The competitive forces in markets with network effects and switching costs is described in an increasing number of business and market studies; see, for instance, Shapiro and Varian (1998) and the noteworthy contribution by Gawer and Cusumano (2002) who develop the concept of platform competition.

Microsoft) where Nintendo hold a dominant position in the eighties and nineties, then lost its dominance while most recently, Nintendo re-gained its dominance.<sup>2</sup>

A close investigation of all those cases, of course, will produce many reasons for particular market dynamics under specific market environments. However, at a more general level, all those cases have a few aspects in common: Firstly, few (in most cases only two) incompatible technologies compete against each other, secondly, network effects play an important role in determining the consumer value of a technology, and thirdly, consumers have to incur switching costs when they decide to substitute one technology against the other.

In this paper we develop a simple model which incorporates those features, and which allows us to answer the following questions: *ii*) How does the evolution of firms' market shares depend on the interplay between network effects and switching costs? *ii*) Which forces drive markets into monopolization on the one hand and market sharing on the other hand?

Our paper contributes to the literature that deals with competition in markets with network effects and switching costs.

In this paper we analyze how market shares of the firms evolve in a duopoly market with network effects and consumer switching costs for any initial market shares of the firms when firms compete in prices. We first analyze a one-period game and then repeat it assuming that firms are myopic and maximize their one-period profits. We find that the evolution of the firms' market shares depends solely on the firms' initial market shares and the parameter  $k$  which shows the relative importance of the switching costs coefficient compared to the network effects coefficient. We find four different patterns of firms' market shares dynamics. Two of them "monotone market-sharing outcome" (Beggs and Klemperer, 1992) and "alternative market-sharing outcome" (To, 1996) are known in the literature. Under the first scenario the dominant firm continuously loses some of its installed base and market shares of the firms approach one half. Under the second scenario the difference between the market shares of the firms decreases but in every period the firm which was initially dominant loses its dominant position to the other firm. The first scenario arises in our model when  $k$  takes the values larger than one when switching costs are stronger than the network effects and the second one when  $k$  takes the values

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<sup>2</sup>See "Wii and DS Turn Also-Run Nintendo Into Winner in Videogame Business," Wall Street Journal online, April 19, 2007 (<http://online.wsj.com>)

smaller than one half when network effects are much stronger than the switching costs. We find out that “monotone monopoly outcome” and “alternative monopoly outcome” are also possible. Under monotone monopoly outcome initially dominant firm increases in every period its market share and gains the monopoly position after reaching the critical value of the market share. Under alternative monopoly outcome the difference in the firms’ market shares increases and again the firm which reaches the critical value of the market share gains in the next period the dominant position. It is important to note that under the monotone monopoly outcome the firm which was initially dominant will gain the monopoly position after some periods and under alternative monopoly outcome any of the two firms may in the end gain the whole market. These patterns of firms’ market shares dynamics arise when  $k$  takes the values between one half and one when network effects are stronger than the switching costs but the latter are still strong.

We also find stationary and stable equilibria. Under stationary equilibrium we understand an equilibrium with the firms’ market shares such that if the initial market shares are equal to these values then they do not change in the equilibrium. Under stable equilibrium we understand an equilibrium with the firms’ market shares such that there is a neighborhood of this value such that whenever the firm’s initial market share lies within this neighborhood the equilibrium market share will be closer to the stable equilibrium than the initial market share. We find that for the values of  $k$  larger than one in the only stable and stationary equilibrium both firms share the market equally. When  $k$  takes the values in the interval between one and the half there are two stable and stationary equilibria in which one of the firms gains the whole market. And for the values of  $k$  lower than one half there are no stable and stationary equilibria. Thus our results show that under strong network effects consumer may be locked-in only when switching costs are also strong, under only strong network effects consumers are never locked-in and can switch from the firm which has already gained the monopoly position. Under strong switching costs consumer lock-in is also not that severe since consumers switch in every period from the dominant firm.

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