Margit Vanberg

Competition and Cooperation Among Internet Service Providers

A Network Economic Analysis

Nomos
# Table of Contents

List of Abbreviations

1 Introduction

1.1 The Internet as the communications platform of the future
1.2 The role of sector-specific regulation or competition policy in the Internet
1.2.1 Typical cost and demand characteristics of network industries
1.2.2 Current regulation concerns in the Internet
1.3 Overview of the thesis

2 Defining Internet service provision

2.1 Standard definitions of Internet service provision
2.2 Differentiating Internet core and Internet periphery
2.3 A layered model of Internet services provision
2.4 Conclusions

3 Historical and technical background of the Internet

3.1 Short history of the Internet
3.2 History of computer communication and Internet transport services
3.2.1 Computer networking
3.2.2 Developments in network interconnection
3.3 History of the Internet hierarchy
3.4 Design and development of the TCP/IP Protocol
3.4.1 Packet-switching research
3.4.2 The TCP/IP protocol
3.4.3 IP addresses, autonomous system numbers and the domain name system
3.4.4 Routers and routing
3.4.5 Quality of service differentiation in Internet routing software
3.4.6 Internet standardization and current developments
3.5 History and development of interconnection agreements
3.5.1 Terms and conditions of Internet interconnection today
3.6 Conclusions
4 A framework for localizing market power in network industries 62

4.1 Justifying government intervention into markets 62
4.2 Competition policy vs. sector-specific regulation 64
4.3 Criteria for judging competition in network industries 66
4.3.1 Sufficient conditions for natural monopoly 66
4.3.2 Theories of monopolistic competition 67
4.3.3 Entry barriers 69
4.4 A reference model for justifying sector-specific regulation in network industries 70
4.4.1 The theory of monopolistic bottlenecks 71
4.4.2 The disaggregated regulatory approach 72
4.5 Justifying interventions by general competition policy in network industries 74
4.6 Conclusions 74

5 Disaggregated analysis of the market for Internet service provision 76

5.1 Claims of market power in Internet service provision 76
5.2 Essential network elements of Internet service provision 78
5.3 Analysis of the cost characteristics of the network elements on the Internet applications and Internet content layers 80
5.4 Analyzing the cost characteristics of the logical layer of the Internet 81
5.5 Analyzing the cost characteristics of the physical layer of the Internet 84
5.6 Conclusions 89

6 Network externalities 90

6.1 Characteristics of network externalities 90
6.1.1 Technology effect vs. network effect 90
6.1.2 Direct and indirect network externalities 92
6.1.3 Pecuniary network externalities 93
6.1.4 Pareto-relevance of network externalities 93
6.2 General competition policy and network externalities 94
6.3 Market processes in the presence of network externalities 96
6.3.1 Case 1: Network externalities in a monopolistic bottleneck 97
6.3.2 Case 2: Network externalities in a contestable natural monopoly 99
6.3.3 Case 3: Network externalities in a competitive market 105
6.3.4 Compatibility standards 111
6.4 Conclusions 114
7 Competitive effects of network externalities in the context of the Internet

7.1 Network effects in Internet service provision
7.2 Terms of interconnection among IP-based networks in a competitive market environment
7.2.1 Costing and pricing of Internet transport services
7.2.2 The price for transit interconnection
7.2.3 The implicit price for peered interconnection
7.3 Dominance on Tier-1 level
7.3.1 The Crémer, Rey and Tirole model
7.3.2 Critique of the model by Crémer, Rey and Tirole and alternative modeling
7.4 Collusion on the Tier-1 level
7.5 Conclusions

8 Policy conclusions

8.1 The threat of market-power leveraging
8.2 The regulatory framework
8.3 Regulation recommendations
8.3.1 The extent of the monopolistic bottleneck in the public switched telephone network
8.3.2 The extent of the monopolistic bottleneck in next generation networks
8.4 Conclusions

9 Regulatory framework for electronic communications in the United States and the European Union

9.1 The regulatory framework for the telecommunications industry in the United States
9.1.1 History of telecommunication regulation in the United States
9.1.2 The present regulatory framework
9.1.3 Assessment of telecommunications regulation in the U.S.
9.2 The Regulatory framework in the European Union
9.2.1 History of telecommunications regulation in Europe
9.2.2 The present regulatory framework in Europe
9.2.3 Local access regulation relevant to Internet service provision
9.2.4 Current developments
9.2.5 Assessment of telecommunications regulation in Europe
9.3 Network neutrality regulation
9.4 Conclusions