



Atso Andersén

ESSAYS ON STOCK EXCHANGE
COMPETITION AND PRICING

HELSINKI SCHOOL OF ECONOMICS

ACTA UNIVERSITATIS OECOMICAE HELSINGIENSIS

A-252

Atso Andersén

ESSAYS ON STOCK EXCHANGE
COMPETITION AND PRICING

HELSINKI SCHOOL OF ECONOMICS

ACTA UNIVERSITATIS OECONOMICAE HELSINGIENSIS

A-252

© Atso Andersén and
Helsinki School of Economics

ISSN 1237-556X
ISBN 951-791-917-4
ISBN 951-791-918-2 (Electronic dissertation)

Helsinki School of Economics -
HeSE print 2005

Abstract

This study deals with the industrial structure, the nature of competition and the pricing of stock exchange trading services in Europe. Specific for the study is that exchanges are considered to be profit-maximizing institutions that face competition.

A conventional analysis of concentration ratios shows that the concentration of European stock exchanges is low. When the nature of competition is measured in more detail, regression results indicate that exchanges operate in monopolistic or perfect competition at the European level.

Pricing of stock exchange matching services under network externalities is studied in a three-layered spatial model. The model presents a monopoly exchange and interaction between two brokers providing trading services to investors in an uncovered market. A case for investor-level network externalities is examined. Three different vertical industry structures were analyzed: no collusion, collusion between brokers, and vertically integrated industry. It was found that the vertically integrated structure results in the lowest fees and the highest demand as well as in the highest profits for brokers.

Finally, the empirical determination of the optimal pricing of share trading services is studied. In particular, optimal price schedule is determined for the Helsinki stock exchange. The estimation results indicate that the market level demand for trading services is elastic. Moreover, the fee structure of Helsinki stock exchange is found to be multidimensional compared with other stock exchanges.

Keywords: stock exchange competition, network externalities, nonlinear pricing, trading services, Europe

JEL classification: D43;L13;G29

Foreword

I wish to thank my adviser, Professor Pekka Ilmakunnas, who has patiently commented my dissertation from its initial phase. I am also grateful to official examiners Docent Ville Aalto-Setälä and Professor Otto Toivanen for their insightful comments and suggestions.

Moreover, I want to thank Professor Juuso Välimäki, Professor Pertti Haaparanta, Professor Klaus Kultti, Dr. Ari Hyytinen and Dr. Juha Tarkka for discussions, encouragement and other contributions. I am unable to mention all the persons that have helped me during the research project. However, I want to express my thanks to Ms. Liisa Jauri, Mr. Jouni Torasvirta and other personnel of the Helsinki exchanges for contributing to my project. My special thanks go to Sami Yläoutinen for sharing the wins and set-backs over the course of the post-graduate studies and to Arto Hakkarainen of HSE for advising me in administering my work. Finally, I would like to thank all the participants of FPPE seminars on Industrial Organization and Capital and Financial Markets during 2002-2003 and the HSE seminar in spring 2003 for their comments.

I am indebted to the Alfred Kordelin Foundation and HSE Centre for Doctoral Studies for enabling this project. I also wish to thank Yrjö Jahnesson Foundation, Research Foundation of Savings Banks, The Finnish Foundation for Advancement of Securities Markets, The Finnish Foundation for Economic and Technology Sciences – KAUTE, HSE Foundation and the Research Foundation of Co-operative Banks for financial support.

It was an adventure of research. This study is dedicated to my dear family Johanna, Reko and Tore.

Espoo, 8th of April, 2005

Atso Andersén

Author	Atso Andersén Helsinki School of Economics Department of Economics P.O. Box 1210, 00101 Helsinki, Finland atso.andersen@hkkk.fi
Title	Essays on Stock Exchange Competition and Pricing
Supervisor	Pekka Ilmakunnas Professor
Preliminary Examiners	Ville Aalto-Setälä Docent, Research Director Turku School of Economics, Pori Unit Otto Toivanen Professor, Director Helsinki Center of Economic Research
Chairperson (Custos), Dissertation Proceedings	Pekka Ilmakunnas Professor Helsinki School of Economics
Opponent,	Ville Aalto-Setälä Docent, Research Director Turku School of Economics, Pori Unit
Type of Research	Based on essays
Essays	Atso Andersén, “Competition Between European Stock Exchanges”, <i>HSE Working Paper W-342</i> , 2003.
	Atso Andersén, “Pricing of Stock Exchange Trading – The Role of Network Externalities”, <i>Unpublished</i> .
	Atso Andersén, “Assessing Demand for and Pricing of Stock Exchange Trading Services”, <i>Unpublished</i> .

Table of Contents

ABSTRACT	3
FOREWORD	5
INTRODUCTION	13
1 COMPETITION? - STOCK EXCHANGES ARE MONOPOLIES, AREN'T THEY?	15
2 THE INCREASING ROLE OF FINANCIAL MARKETS	16
3 OVERVIEW ON STOCK EXCHANGE COMPETITION AND PRICING LITERATURE	23
3.1 Identifying the nature of stock exchange competition	24
3.2 Network externalities involved in trading services	27
3.3 Pricing stock exchange trading	28
4 MOTIVATION FOR THE THESIS	30
5 OUTLINE OF THE THESIS	31
5.1 The first essay: Competition between European Stock Exchanges	32
5.2 The second essay: Pricing of Stock Exchange Trading – The role of network externalities	33
5.3 The third essay: Assessing demand for and pricing of stock exchange trading services	35
ESSAY I: COMPETITION BETWEEN EUROPEAN STOCK EXCHANGES	43
1 INTRODUCTION	46
2 THE INDUSTRIAL STRUCTURE OF EUROPEAN STOCK EXCHANGES	47
2.1 Income structures	50
2.2 Vertical structure of the share trading services industry	54
2.3 Institutional factors in stock exchange competition	55
2.4 Is there one European stock market, after all?	59
3 A THEORETICAL FRAMEWORK FOR MEASURING THE LEVEL OF COMPETITION	61
3.1 A specification of the empirical model	64
4 EMPIRICAL ESTIMATION RESULTS	67
4.1 Data	67
4.2 The exchange industry estimations	68
5 CONCLUDING REMARKS	71
REFERENCES	73
APPENDIX 1 PRICE SCHEDULES FOR MATCHING SERVICES IN EUROPEAN EXCHANGES 2002	76
ESSAY II: PRICING OF STOCK EXCHANGE TRADING – THE ROLE OF NETWORK EXTERNALITIES	79
1 INTRODUCTION	82
2 THE MODEL	85
2.1 The industry set-up	86
2.2 Investors	87
2.3 Brokers and the exchange	89
3 FEES UNDER INVESTORS' NETWORK EXTERNALITY	90
3.1 Brokers' collusion	94
3.2 Joint profit maximization	97

3.3	The impact of vertical integration under investor externality	99
4	CONCLUSIONS.....	101
REFERENCES		102
ESSAY III: ASSESSING DEMAND FOR AND PRICING OF STOCK EXCHANGE TRADING SERVICES.....		105
1	INTRODUCTION	108
2	THE OPERATIVE LANDSCAPE OF THE HELSINKI STOCK EXCHANGE.....	112
2.1	Other indications of the competitive landscape of Helsinki stock exchange	114
2.2	Current price schedules of stock exchange trading services	116
3	THE FRAMEWORK FOR ASSESSING TRADING SERVICES	118
3.1	The model of demand.....	119
3.2	The econometric specification of demand.....	124
4	DATA AND VARIABLES FOR ESTIMATIONS.....	125
5	ESTIMATION PROCEDURE AND RESULTS	129
5.1	Results	130
5.2	Robustness of results	134
6	ASSESSING TRADING SERVICES PRICING IN THE HELSINKI STOCK EXCHANGE 135	
6.1	The model of supply of trading services	135
6.2	The structure of the reconstructed price schedule.....	136
7	CONCLUSIONS.....	141
REFERENCES		142
APPENDIX 1 DERIVATION OF PROFIT MAXIMIZATION CONDITION		144
APPENDIX 2 PRICING SCHEDULES OF THE HELSINKI STOCK EXCHANGE		146
APPENDIX 3 ESTIMATION RESULTS FOR OLS MODELS.....		147
APPENDIX 4 ESTIMATION RESULTS FOR SUR-SYSTEM.....		148

Introduction: Essays on Stock Exchange Competition and Pricing

In recent decades, economic systems have become increasingly market-based. More than ever, we follow stock market prices worldwide and make decisions based on economic information. This applies to companies and increasingly to individuals in the industrial countries and elsewhere. Technological development and internationalization enable investment in stocks abroad either through institutions like funds or even directly. Deregulation of the financial markets has supported the development of global trading.

These developments raise many questions. The fundamental questions of my thesis mainly concern the economic institutions involved. Are the institutions that create financial markets efficient, sustainable or stable? How will these institutions endure further development and demographic changes such as ageing? Recent developments in the Western stock market institutions have raised doubts about the activities conducted by brokers, exchanges and other stock market institutions. In particular, I attempt to analyze exchanges in the light of principles familiar from the industrial organization literature. My aim is to contribute to an emerging discussion about the form and future of sustainable stock market institutions.

In general, there exists an extensive literature covering issues on investor, market and company behavior related to financing investments and managing assets. Moreover, the literature on the operations and role of banking institutions is extensive. However, only a handful of studies considering the functionality of stock market institutions can be

found. Nevertheless, the branch of formal literature on stock exchanges has recently emerged. Other stock market institutions such as securities houses and settlement and clearing institutions are analyzed to an even lesser extent. I argue that without substantive literature based on common assumptions and models applied from other industries and banking institutions, in particular, we are not able to analyze developments in the basic structures of stock market institutions. Without solid knowledge of the stock market institutions require for an efficient operation the stability of the entire financial system cannot be ensured.

These observations provide a starting point for my thesis. Moreover, the operative landscape of European exchanges has changed due to the European Monetary Union and changes in the corporate governance systems of exchanges. Notably, the majority of the largest European stock exchanges have turned into for-profit organizations during the 1990s and some even before that. Therefore, I use the assumptions of profit-maximization and potential competition between European stock exchanges as a basis for the research.

This thesis focuses on two questions that have not been widely studied in the literature: industrial structure and pricing of stock exchange trading services. In order to justify the assumption of competitive exchanges, I attempt to characterize concentration levels and measure the nature of competition between European stock exchanges. When it comes to pricing, I aim to apply spatial pricing models for the case of the stock exchange industry. Finally, I provide empirical results on determining the optimal price schedule for the Helsinki stock exchange.

These issues are worth studying, in order to provide instruments that help to ensure the availability of market-based finance and to develop efficient stock market institutions. I

hope this thesis will help to create a piece of formal literature for analyzing and developing stock exchanges and other stock market institutions as well.

Before proceeding to a more detailed literature review, let me impose necessary limitations and caveats. This thesis considers only the largest European stock exchanges. However, special attention is paid to the Helsinki stock exchange. To some extent the results can be generalized to other stock exchanges and brokers as well. When it comes to analyzing competition, such rivals as stock exchanges in the United States, Japan, Asia or other continents of the world are not included. Most importantly, the thesis focuses on trading services. Hence, no other elements of the value chain of stock trading are included. For instance, the impacts of settlement and clearing activities, market information services and other potential services are not analyzed. Finally, requirements of rigorous theoretical modeling and empirical estimation have forced me to use simplifications and approximations.

1 Competition? - stock exchanges are monopolies, aren't they?

The majority of stocks listed in stock exchanges are listed only in that particular stock exchange. Secondly, stock exchanges are regional monopolies as they have traditionally been national institutions. Thus, it can be argued that there is no competition between exchanges.

This argument certainly holds, but if stocks are considered as financial instruments, the competition argument becomes more rational. The value of a stock for an investor consists of discounted dividend payments or more broadly defined, of discounted future cash flows that turn into dividends. Hence, for the investor stocks are not that unique, after all. It can be argued that an international investor seeks the lowest prices for the

highest dividends streams. Otherwise, the international investor is indifferent where the purchase of such a stream takes place.

Next, the international investor considers how the trade is executed. When it comes to trading services provided by stock exchanges, the content of the service is universal: execution of a purchase or a sell of stocks. Then the investor considers trading costs of executing trades, i.e. the price of trading. Generally, trading costs consist of implicit costs, such as liquidity (or spread) costs, and external costs, such as trading fees set by exchanges. Stock exchanges can have a direct impact only on their fees, and not on liquidity. Liquidity is a result of a network externality created by a large number of investors gathered at one trading place.

In sum, a starting point in this thesis is that stock exchanges sell trading services associated with a product of discounted cash flows, which are broadly similar across exchanges. As trading services are also universal, competition can take place among stock exchanges. Hence, I found it worthwhile to examine whether there is evidence of competition between stock exchanges.

When it comes to theoretical modelling of network externalities and assessment of pricing, however, the exchange is assumed to be a monopoly. This is done in order to focus on the roles of network externalities and non-linear pricing. These phenomena are typical for the stock exchange industry and existed far longer than competition among exchanges.

2 The increasing role of financial markets

The increasing role of the financial markets is characterized by a brief literature review on the link between macroeconomic performance and the structure of the financial

system and by illustrating how the role of market-based financial instruments have increased over the past decades.

In recent literature, it is widely stated that the role of market-based finance has increased during the last fifteen years (e.g. Aylward and Glen 1999). This phenomenon has had an impact on other parts of the economy as well. Generally, it is argued that in the market-based system financing through primary markets provides flexibility for riskier projects compared with a bank-based system (Allen and Gale 1995). Through secondary markets, asset management activities allow efficient allocation of funds and means for risk-sharing.

The need for efficient operation of the market economy institutions is very important from a structural perspective of society as well as for demographic reasons. In the long run, inefficiency of stock market institutions leads to high transaction costs compared with other financing possibilities (e.g. Allen and Gale 2001). If transaction costs remain high, the interest of the society to use the stock market as a vehicle to intermediate finance should decrease or alternative solutions should emerge. The demographic reasons for the need for efficient stock markets include two aspects. Age structures in the industrialized countries are becoming top-heavy, indicating an increasing need for pension funds management. Pension systems are already increasingly dependent on stock markets. If the efficient functioning of stock market institutions is not guaranteed, pension systems may also suffer from instability. Second, from the macroeconomic point of view, efficient functioning of financial market institutions increases growth (e.g. King and Levine 1993, Levine 1997, Rajan and Zingales 1996, Beck and Levine 2004, Allen and Gale 2001) and mitigates business cycles (e.g. Carlstrom and Fuerst 1997, Suarez and Sussman 1997, Bernanke and Gertler 1989, Gertler 1992, Greenwald,

Stiglitz and Weiss 1984 and Fuerst 1995). The history of banking crises and collapses of other stock market institutions provide evidence of the macroeconomic importance of stock market and banking institutions (e.g. Allen and Gale 2001). Generally, unstable or inefficient stock market institutions and the banking sector propagate business cycles by being too active at the top of the cycle and inactive at the bottom. This creates over-investment in the boom and barriers for investments in the recession. Efficient functioning of stock markets and the banking sector provides a stable basis for financing over the business cycle. Ultimately, the efficiency of the system arises from the operation of stock market and banking sector institutions.

Even though the functions of financial markets and the problems involved (such as the propagation of the business cycle) have been studied, there is an evident shortage of formal studies on the behavior and efficiency of stock exchanges, securities houses, clearing and settlement institutions, institutional investors and other related institutions from the viewpoint of conventional industrial organization.

Evidently, market capitalization of world's stock markets has increased rapidly in recent decades. But so have amounts of loans, deposits and debt market instruments. It is often argued that the long-term growth rate of assets follows the growth rate of GDP. Is it really so that the role of financial markets has increased in the financial structures (or financial architectures) in this kind of dynamic set-up? The following descriptive statistics are based on the World Bank's database on financial development and structure. I will focus on the Nordic countries, due to the most extensive availability of data. Figure 1 clearly illustrates the case that I have in mind. There has been a trend-like increase in all the stock market indicators. When it comes to deposits, the growth rate has followed GDP growth whereas the role of bond markets has declined. On the

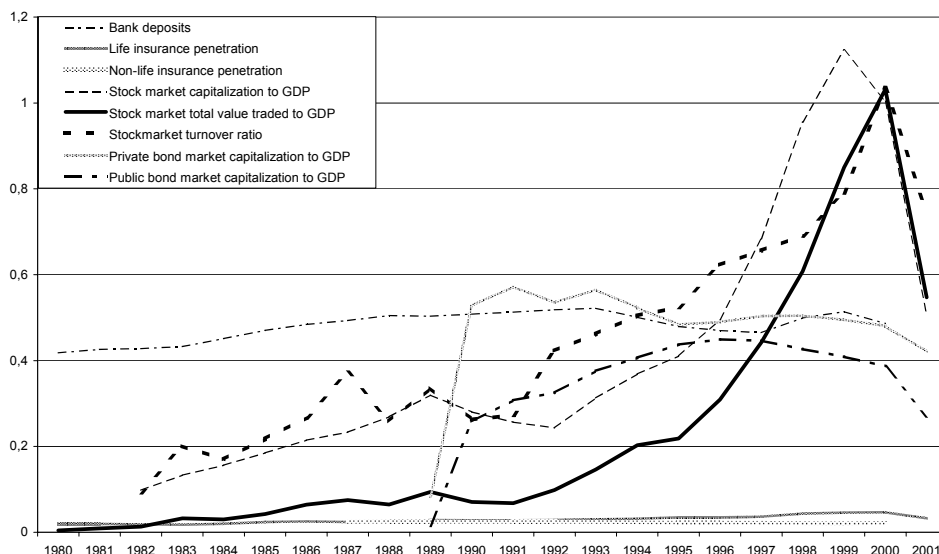
basis of the figure, I also ask the reader to note the rapid increase in indicators related to stock market activity such as the ratio of stock market total value traded to GDP and the ratio of value of turnover to stock market capitalization. According to Beck et al. (2000) value traded to GDP measures liquidity of the market whereas turnover ratio can be interpreted to describe market activity.

It remains to be seen whether the sharp decline in the stock market-based measures will be permanent. However, the bursting of the stock-market valuation bubble in the 1999 seems to have returned stock market indicators closer to their long-term trend. Such a collapse in bank credit portfolios would probably have led to full-scale bank crises. It is surprising that the operation and efficiency of stock market institutions has not been the subject of a major discussion in the Nordic countries.

It is also worth noting that the size of stock market capitalization was below that of the outstanding amount of bank deposits until mid-1990s. Hence, it can be argued that larger-scale usage of market-based instruments for asset management and finance lacks traditions as a business compared with banking in the Nordic countries.

Figure 1.

The structural measures of the financial system in the Nordic countries, average

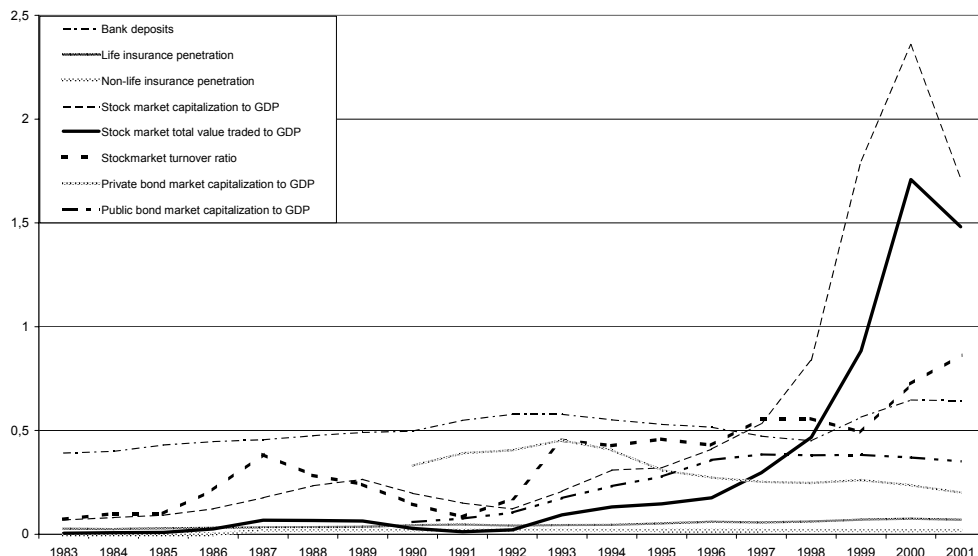


Source: World Bank

When it comes to a generality of the increase in the role of market-based financial structures Beck et al. (2000) show that broadly taken, a similar pattern of development applies to the whole world irrespective of the initial level of GDP of the country. In Finland, this development has been remarkably strong, as can be seen in figure 2. In fact, the case of Finland is based on a phenomenal rise of a telecommunication company, Nokia. Therefore the statistics can be argued to be misleading if it is interpreted to characterise the overall structure of the Finnish financial system. On the other hand, it can be stated that the rise of the stock markets' importance in Finland is due to Nokia's success.

Figure 2.

The structural measures of the financial system in Finland

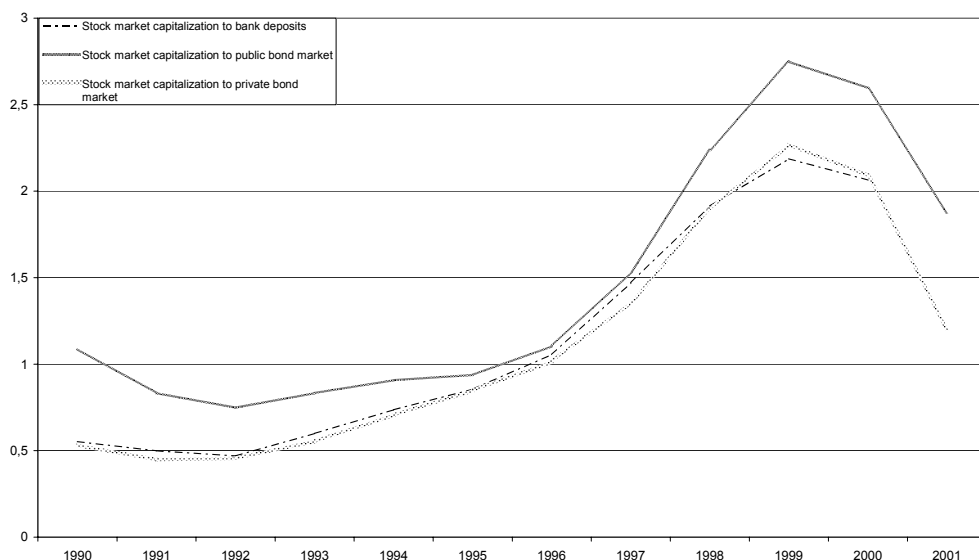


Source: World Bank

In general, it can be argued that capital accumulation (i.e. growth of capital resources) as such increases the outstanding amount of bank deposit as well as the capitalization of stock and bond markets. In fact, the trend in capital accumulation underlines the growing importance of stock markets, the operation of the institutions involved and the need for formal analysis on the operation of involved institutions. Figure 3 provides supporting evidence by showing that the role of stock markets has increased compared with deposits and with both private and public bond markets. In Finland, this development has been even more pronounced. Unfortunately, the data covers only a period of approximately ten years, which includes only one business cycle in the Nordic countries. However, Beck et al. (2000) illustrate similar development over three decades for the average of countries in the World Bank database.

Figure 3.

The role of stock market capitalization with respect to deposits and bond market capitalization in the Nordic countries



Source: World Bank

Further evidence on the change in the financial structures can be found from financial accounts of households. Table 1 presents financial accounts of Finnish households for 1996-2002. Against a modest growth of deposits, the increases in direct equity holdings, mutual funds and insurance reserves are significant. As insurance reserves are also generally related to pension or life-insurance schemes that are based on equity investments, all these account items indicate the increasing role of possessions of market-based asset-management instruments. Naturally, conventional financial intermediaries such as banks and insurance companies are involved in these activities. However, the table also underlines the fact that activities related to asset-management are a new phenomenon among Finnish households.

Table 1.

Households financial assets and liabilities in Finland 1996-2002

Financial Assets								
<i>Million EUR</i>	1996	1997	1998	1999	2000	2001	2002*	Growth 1996-2002
Currency and transferable deposits	26 470	26 255	31 849	33 601	33 979	35 243	36 179	37 %
Other deposits	12 685	13 433	9 291	9 607	9 831	10 367	10 617	-16 %
Bonds	3 372	2 950	2 374	1 680	1 478	2 003	1 368	-59 %
Loans	243	269	301	311	376	416	471	94 %
Quoted shares	6 980	9 811	12 432	28 359	25 802	18 987	15 269	119 %
Other shares and equity, excl.mutual funds share	14 075	15 159	21 673	22 616	25 568	25 428	28 753	104 %
Mutual funds shares	675	1 050	1 897	4 000	5 126	5 258	4 896	625 %
Insurance technical reserves	10 175	12 563	15 136	17 196	26 367	28 016	30 572	200 %
Other accounts receivable and payable	717	576	2 784	2 741	3 161	3 097	6 028	741 %
Financial assets, total	75 392	82 066	97 737	120 111	131 688	128 815	134 153	78 %

Liabilities								
<i>Million EUR</i>	1996	1997	1998	1999	2000	2001	2002*	Growth 1996-2002
Loans	30 871	31 210	33 436	36 578	39 606	42 686	46 696	51 %
Other accounts receivable and payable	1 491	1 583	2 071	1 624	1 726	1 791	2 973	99 %
Liabilities, total	32 362	32 793	35 507	38 202	41 332	44 477	49 669	53 %
Net financial assets	43 030	49 273	62 230	81 909	90 356	84 338	84 484	96 %

*Preliminary figures

Source: Statistics Finland

On the basis on this illustrative literature review and statistics, I would venture to argue that the formal analysis of institutions and operation of market-based financial structures are of urgent importance and worth a detailed analysis.

3 Overview on stock exchange competition and pricing literature

The approach used in this study arises from an emerging branch of literature, which is based on the idea that industrial structure of stock market institutions cannot be fully characterized by studying only the demand side of the stock market related services (Domowitz and Steil 1999). Initially, this approach was introduced when the consolidation of regional exchanges in the United States was studied (Arnold, Hersch, Mulherin and Netter 1999). Before that, exchanges and competition were theoretically considered in a spatial framework (Gehrig 1998, 2000). Moreover, the structures of the

other financial and commodity exchange industries (however, excluding stock exchanges) were found to resemble monopolies (Pirrong 1999). Setting a more structured basis for the approach, the nature of competition and integration among the European stock exchanges was studied (Di Noia 1999). Building on this basis, a branch of literature considering conventional industrial organization issues such as scale and scope economies, cost and revenue efficiencies, effects of automation and technology on trading services and identification of network advantages emerged (Malkamäki and Topi 1999, Malkamäki 1999, Hasan and Malkamäki 2000, Schmiedel 2004). Deeper examination of the supply side behavior was provided when pricing of stock exchange primary market services for investors was studied in the case of implicit mergers and competition (Shy and Tarkka 2001). The article of Shy and Tarkka also addresses a potential connection between modeling telecommunications industry and stock exchange industry at the theoretical level.

These recent studies suggest that the supply side approach of research is coherent and that further studies are likely to provide useful analysis of contemporary stock exchange behavior. I attempt to characterize competitive conditions of stock exchanges, the role of network externalities and the optimal pricing of trading services in Helsinki stock exchange. As there are no previous studies considering these issues in the case of stock exchanges, I will build on literature studying measurement of market power and pricing familiar from e.g. banking and telecommunication services.

3.1 Identifying the nature of stock exchange competition

In formal literature identifying the nature of competition and measurement of market power have been central questions of empirical research in the industrial organization literature for a long time. Bresnahan (1989) summarizes the development of the

literature. Nowadays, focus of the research is on attempts to measure competitive behavior directly on the basis of demand and price information. Also additional structural information can be used. This approach is called the “new empirical industrial organization” (NEIO) approach. Competitive conduct will be determined by estimating how firms make price and quantity decisions. On the other hand, the approach focuses on taking into account industry-specific structural factors. The aim in the studies representing the NEIO approach is to find empirical support for the variables defined in the theoretical models of competition and industrial organization of different industries. According to Bresnahan (1989), the NEIO approach is based on four main arguments. First, price-cost margins cannot be reliably tracked from accounting information. Second, individual industries have unique institutional features that cannot be generalized. Third, estimation specifications of industry conduct should be based on analytical models so that estimated parameters can be linked to the theory. Fourth, the inference of market power should be made clear so that the evidence of the conduct results from data and the estimation procedure.

Basically, NEIO research has evolved as a criticism against the previously dominant method of analyzing the relationship between concentration of producers and the performance of the industry (the “structure-conduct-performance approach”, SCP). Generally, SCP models identify a positive relationship between industry concentration and firm profitability. However, several caveats are often highlighted (Bresnahan, 1989). First, SCP methods rely on accounting information, which directly states the price-cost margins (performance) in the first place. Moreover, accounting figures can be manipulated and they differ country by country or sometimes even industry by industry. Second, it is debatable whether high profits are a sign of high or low efficiency/performance of the industry. Third, it is difficult to determine the correct

concentration measure on the basis of oligopoly theory as different (industry-specific) factors often have an impact on the measurement. Fourth, the link between concentration and performance cannot be straightforwardly specified from theory. In sum, it can be argued that measurement and specification problems form criticism against the SCP approach. However, concentration measures and profitability are widely used for descriptive purposes. In fact, I will also characterize features of the European stock exchange industry by measures once used in SCP approach studies.

Empirical NEIO models measuring the nature of competition are widely used, especially in the case of financial institutions such as banks. Recently, market power in banking has often been measured by using the method of Panzar and Rosse (1987) (for instance, Vesala 1995, De Bandt and Davis 2000 and Bikker and Haaf 2002). Basically, the Panzar-Rosse method studies the relationship between factor inputs and firm revenues. By using a reduced-form revenue equation, it is possible to estimate elasticities between these revenues and factor-costs and to create a measure that gives an indication of the competitive conduct.

It is worth noting that research using the NEIO approach on the linkage between competition and industrial organization is under continuing development as well. For instance, according to Hyde and Perloff (1995), the method of Panzar and Rosse is powerless in the case of the Cobb-Douglas specification. Moreover, they argue that the method is in general sensitive to the functional form of the estimated equation and also to the (structural and/or technical) factors included in model specification.

Even though the Panzar-Rosse method has been criticized, it is straightforward to use and requires relatively little data while still providing yet indicative results. As it has

been successfully used for banking industries, I am encouraged to apply it to the stock exchange industry as well.

3.2 Network externalities involved in trading services

Network externalities are characteristic for the trading industry. Externalities concern both investors and market institutions.

Investors gain utility arising from an externality effect related to their number. The more investors there are, the higher is the utility involved in trading (see Economides 1993). This is due to the fact that in the more liquid market, spread¹ involved in trading diminishes and time to have trades executed shortens. This is equivalent to the externality common in the telecommunications industry, where a larger network means better connectivity. Moreover, Economides also proposes another kind of externality; underpriced provision of market price information to outside rivals. The more active the market is the more accurate is the pricing of traded shares.

Investors' spread-related costs are revenues of brokers that act as market-makers². Therefore, brokers are subject to negative network externality as the number of investors increase. On the other hand, brokers gain spread-related revenues that decline as the market becomes more liquid. Basically, a broker earns the bid-ask spread from every trade as it purchases the shares from the seller and sells them to the buyer³. Moreover, brokers themselves also incur execution costs per trade due to liquidity of the market. In the case of low liquidity, brokers must devote more effort/time to find the matching order. The larger the total market, the smaller these liquidity-related costs

¹ A difference between bid and offer quotes.

² A market-maker is committed to provide bid and offer quotes for defined stocks.

³ As brokers do not hold stocks overnight, the equal amount of purchases and sells during the day is equal. Thus spread income is realized daily.

are. Hence, a positive network externality is also involved. The combination of these two effects can be argued to be negative for brokers. This assumption reflects the empirical argument that spreads tend to diminish as trading volume and competition between brokers increase. In such circumstances providing trading services becomes less profitable. Moreover, larger markets often involve a greater number of brokers. As the level of competition increases, profits decline.

When it comes to exchanges, they arguably have economies of scale in production. Evidence of economies of scale associated with stock exchanges is presented in e.g. Malkamäki (1999). On the basis of cost function estimations, he argues that economies of scale are present especially in trading services among large stock exchanges. Moreover, no such scale advantages were found in the case of company-specific services. On the other hand, as exchanges maintain the network, it can be argued that network externalities of investor and broker levels do indirectly benefit exchanges as well.

Hence, network externalities play a key role in providing trading services. Therefore, I attempt to give insight into the significance of externalities by considering them in association with a theoretical spatial model of the stock exchange industry.

3.3 Pricing stock exchange trading

The literature analyzing pricing of stock trading services has focused on the analysis made from demand perspective. The extensive literature on market microstructure approaches the issue by considering the costs of transaction services from investor and broker viewpoints (see the review of Stoll 2001). Moreover, the analysis emphasizes the role of a bid-ask spread, but also pays attention to commissions. These demand side studies can provide some indication of the supply of trading services. In the literature

on total trading costs, the costs are generally divided into explicit costs like fees and commissions and implicit costs such as market impact costs (e.g. Berkowitz et al. 1988 and Domowitz et al. 2000, Domowitz 2002). In general, the market microstructure literature suggests that quantity discounts are commonly used in pricing trading services (Stoll 2001). Furthermore, the trading patterns are argued to include network externalities (e.g. Economides 1993). Nevertheless, to understand how trading services are priced, research from a supply side perspective is needed.

The tools and concepts for the supply side analysis of pricing can be found in the economics of industrial organization and more particularly from the extensive literature on telecommunications pricing and competition. Especially, nonlinear pricing has been extensively studied in the economic literature (e.g. Tirole 1988, Brown and Sibley 1986 and Wilson 1993). Generally, nonlinear pricing is about second-degree price discrimination, which is the case with quantity discounts, for instance. When second-degree price discrimination is applied, prices do not differ according to consumers but according to quantity purchased. So far, the literature on nonlinear pricing has concentrated on monopoly settings (Mitchell and Vogelsang 1991). However, there exists an increasing literature on nonlinear pricing in competitive situations that is potentially applicable to the stock exchange industry (see e.g. Oren, Smith and Wilson 1983, Valletti 1998 and Min et al. 2002, Laffont, Rey and Tirole 1997, 1998a, 1998b, Stole 2003, Armstrong and Vickers 2001 and Yin 2004).

When it comes to empirical work on nonlinear pricing, the studies concerning telecommunication have again focused on monopoly situations, where services are provided directly to final customers (see e.g. Bousquet and Ivaldi 1997 and Aldebert, Ivaldi and Roucolle 2004). Recently, studies on nonlinear pricing in the case of

oligopolistic competition have emerged (McManus 2002 and Miravete and Röller 2003). However, these models use extensive data on final customers in determining demand. In the case of stock trading services such information is rarely available. In order to describe demand behavior at a level that still allows the analysis, a method of demand profiles provides a potential framework for the study (Wilson 1993). The method based on demand profiles emphasizes the relationship between the number of customers and the price for each purchased quantity, instead of the conventional, consumer utility-based analysis of the direct relationship between price and quantity.

The overview of the background literature is by no means comprehensive, but provides me with a point of departure to begin research on the pricing of trading services from the exchange perspective.

4 Motivation for the thesis

In short, there are two important observations that motivate the issues examined in my dissertation:

- 1) Identified gaps in the formal literature.
- 2) The increasing role of market-based finance in the industrialized countries and the related need for the efficient operation of the market economy institutions.

Moreover, in recent years many of the European stock exchanges have “demutualized” (see e.g. Steil 2002). This has likely changed the objectives of the exchanges, which direct their decision-making and activities. Therefore, stock exchange institutions are increasingly organized like firms that operate under the same economic objectives as

other companies. Also, changes such as deregulation and technological development have altered the role of exchanges both domestically and abroad.

The literature overview shows that there are gaps in the formal literature concerning the nature of stock exchange competition and pricing of trading services. This is partly due to the aforementioned changes in the operative environment. Previously, the operative landscape of stock exchanges has not allowed studies based on the assumptions common in the literature on industrial organization. Moreover, the earlier literature has paid limited attention to stock exchanges from the supply side perspective.

Finally, both the brief literature review of the evident link between macroeconomic performance and sophistication of financial markets and illustration of the increasing role of the market-based financial instruments and institutions emphasize the relevance of my research.

These observations have motivated me to write my thesis on competition between European stock exchanges and on the optimal pricing of stock exchange trading services.

5 Outline of the thesis

My thesis consists of three separate essays. The essays consider exchange competition and pricing issues by means familiar from the literature of traditional industrial organization. The first essay considers the competition between European exchanges. The second essay is theoretical by nature, as it examines the role of network externalities of stock exchange trading services. In the third essay, pricing of stock exchange trading services is examined empirically in the case of the Helsinki stock exchange.

These three essays provide a unified ensemble to analyze the competitive landscape and pricing decisions of exchanges.

5.1 The first essay: Competition between European Stock Exchanges

The first essay deals with the industrial structure and the level of competition between European stock exchanges in 1995-2001. The competitive landscape has changed due to deregulation, internationalization and technological development. Therefore, exchanges are studied assuming that circumstances allow potential competition on the European level and that exchanges are profit-maximizing institutions. The essay aims to examine whether there is any evidence of structural change in the European stock exchange industry or of competition between the European exchanges. The analysis includes the exchanges of Copenhagen, Germany, Helsinki, London, Oslo, Stockholm, Switzerland and Euronext (Paris, Brussels, Amsterdam and Lisbon. These exchanges were chosen because of the availability of data. More importantly, these exchanges operate in the same markets due to recent economic integration in Europe.

The industrial structure is characterized by analyzing concentration and income structures of exchanges. Calculations of market shares and concentration ratios are used to characterize concentration in the European exchange industry. The calculations based on market capitalization and turnover figures indicate that the concentration is low, suggesting that the European equity markets are still fragmented. In fact, concentration has decreased during the 1990s. When it comes to income structures, the analysis shows that exchanges' total revenues have steadily increased during the 1990s following the general upward trend in the stock markets. Even though the income structures in individual exchanges have changed significantly, the industry level figures

have remained stable. The analysis shows that sale of information and income from other activities has remained the largest source of revenue.

The level of competition is measured by using the method of Panzar and Rosse (1987). The method is based on measuring the elasticities between revenues and costs of factors of production. Moreover, the approach identifies whether exchanges face monopoly, monopolistic competition, perfect competition or not identified nature of competition. However, more precise level of competition cannot be identified. The choice of the method is based on the earlier literature of analyzing other financial institutions, especially banks. The level of exchange competition is measured at the European level. Moreover, institutional factors such as changes in the number of members, changes in trading systems, and changes in structures of lists are taken into analysis.

The regression results indicate that at the European level exchanges operate in monopolistic or perfect competition. The impact of technical changes in the trading systems on trading revenue is found negative. However, other institutional factors such as changes in the structures of lists and the contribution of an increase in number members have had insignificant impact on trading revenues.

5.2 The second essay: Pricing of Stock Exchange Trading – The role of network externalities

The second essay presents a theoretical model of pricing of stock exchange matching services in a spatial set-up. The presented model contributes to the earlier work by applying the set-up for the three-layer industry of investors, brokers and stock exchanges. Hence it is, by the same token, a model of the industry's vertical structure. In fact, three different vertical industry structures are analyzed: no collusion, collusion between brokers, and vertically integrated industry.

The starting point for the essay is that currently all the European stock exchanges maximize profits. This is an emerging perspective to analyze stock exchanges and is justified on the basis of the first essay. As the focus of the essay is on the role of externalities, a monopoly set-up is applied contrary to the findings of the first essay. The extensive literature on pricing electricity and telecommunication services provides a point of departure for an application on stock exchange trading services.

The objective of the essay is to study how to apply spatial pricing models under network externalities to stock exchange trading services. Basically, the essay aims to fill a gap in the literature and to provide insight into the current matter of the industrial organization of stock market institutions. On the other hand, the model contributes to vertical integration literature by presenting a network externality among customers (investors).

In sum, the impact of an increase in investors' (positive) externality effect on brokers' fees, demand, and profits is found to be positive.

It is also found that the monopoly exchange does not take into account the impact of the investor level externality effect when pricing its services. The independency of the network externality is somewhat counter-intuitive. One would expect that an increase in the externality would also lead to a positive impact on the exchange's fees. However, all the trades will be executed in the exchange despite the level of its fees. On the other hand, the exchange's fees partly determine market coverage, which also takes account of the externality's impact.

It turns out that the joint profit maximization of market institutions (i.e. vertical integration) results in the lowest prices and the highest demand as well as the highest profits under investors' externality effect.

5.3 The third essay: Assessing demand for and pricing of stock exchange trading services

The objective of the third essay is to study how the principles of optimal nonlinear pricing can be applied to the case of share trading services in practice. More precisely, an optimal nonlinear price schedule is determined for share trading services in the Helsinki stock exchange by using a dataset that covers the months between 1999/1-2002/6. In addition, the third essay aims to determine the level of price elasticity of demand for stock trading services faced by the Helsinki stock exchange. The essay also discusses the pricing structures of European stock exchanges and of Helsinki, in particular.

The point of departure for the empirical modeling is the observation that in the literature, empirical studies on nonlinear pricing are scarce, as are articles on pricing stock exchange services. The essay is based on a method introduced by Wilson (1993). According to this method, demand is characterized by determining demand profiles, that measure the number of customers for each purchased quantity. Hence, the impact of price changes is described as a change in the number of customers in each purchased quantity instead of a change in quantity as is usual in traditional demand modeling.

In order to provide a perspective for application of the monopoly modeling for pricing trading services in the Helsinki stock exchange, internationalization and market shares of trading in Finnish stocks are examined. Both the level of foreign ownership and the market share of trading in shares cross-listed with other exchanges indicate that

Helsinki may face competition. However, its market share has remained high, giving justification for the monopoly assumption. The analysis on trading fees indicates that in general European stock exchanges seem to have some degree of nonlinearity in the pricing structures. In the case of the Helsinki stock exchange, the analysis also reveals that the fee structure is highly multidimensional compared with other stock exchanges. In fact, high multidimensionality leads to a caveat in the estimation analysis. The price structure is approximated to include fees per average value of trades under normal daily trading. This simplification is implemented to avoid complexity, which would have been the case if further pricing components had been applied.

The results of estimation analysis show how an optimal non-linear price schedule can be determined for pricing share trading services in the case of the Helsinki stock exchange. It is found that from the perspective of the Helsinki stock exchange, non-linear pricing will be optimal. The market level approximation indicates that the Helsinki stock exchange faces elastic demand for its trading services.

Comparing current fees per trade with simulated optimal price schedules indicates that quantity premiums for the smallest brokers and quantity discounts for the largest brokers could be applied.

References

Aldebert, Marc, Ivaldi, Marc and Roucolle, Chantal (2004): Telecommunications Demand and Pricing Structure: An Econometric Analysis, *Telecommunication Systems*, Vol. 25, No. 1, 2, pp. 89-115.

Allen, Franklin and Gale, Douglas (1995): A Welfare Comparison on Intermediaries and Financial Markets in Germany and the US, *European Economic Review*, Vol. 39, No. 2, pp. 179-210.

Allen, Franklin and Gale, Douglas (2000): *Comparing Financial Systems*, The MIT Press, Cambridge, Massachusetts, London, England 2000.

Allen, Franklin and Gale, Douglas (2001): *Comparative Financial Systems: A Survey*, Wharton Financial Institutions Center Working Paper 2001/15.

Armstrong, Mark and Vickers, John (1993): Price Discrimination, Competition and Regulation, *Journal of Industrial Organization* Vol. 41, pp. 335-59.

Arnold, Tom, Hersch, Philip, Mulherin, Harold J. and Netter, Jeffrey (1999): Merging Markets, *Journal of Finance*, Vol LIV, No. 3, June 1999, 1083-1107.

Aylward, Anthony and Glen, Jack (1999): Primary Securities Markets: Cross Country Findings, IFC Discussion Paper no. 39, June 1999.

Beck, Thorsten and Levine Ross (2004): Stock Markets, Banks, and Growth: Panel evidence, *Journal of Banking and Finance* 28, March 2004, pp. 423-442.

Beck, Thorsten, Demirgüç-Kunt Asli and Levine Ross (2000): A New Database on Financial Development and Structure, *World Bank Economic Review*, September 2000, pp. 597-605.

Berkowitz, Stephen A., Logue, Dennis E. and Noser, Eugene A. Jr. (1988): The Total Cost of Transactions on the NYSE, *Journal of Finance*, Vol. 43, Issue 1, 97-11, March 1988.

Bernanke, Ben and Gertler, Mark (1989): Agency Costs, Net Worth, and Business Fluctuations, *American Economic Review*, Vol. 79, No. 1, pp. 14-31.

Bikker, Jacob A. and Haaf, Katharina (2002): Competition, Concentration and Their Relationship: An Empirical Analysis of the Banking Industry, *Journal of Banking and Finance* Vol 26, 2002, pp. 2191-2214.

Bousquet, Alain and Ivaldi, Marc (1997): Optimal Pricing of Telephone Usage: An Econometric Implementation, *Information Economics and Policy* 9 (1997) 219-239.

Bresnahan, Timothy (1989): Empirical Studies of Industries with Market Power, In Handbook of Industrial Organization, Vol II, edited by R. Schmalensee and, R.D. Willig, Elsevier Science Publishers 1989.

Carlstrom, Charles T. and Fuerst, Timothy (1997): Agency Costs, Net Worth, and Business Fluctuations: A Computable General Equilibrium Analysis, The American Economic Review, Vol. 87 no. 5, December 1997, 893-910.

DeBandt, Olivier and Davis, E. Philip (2000): Competition, Contestability and Market Structure in European Banking Sectors on the Eve of EMU, Journal of Banking and Finance Vol 24, 2000, pp. 1045-1066.

Di Noia, Carmine (1999): The Stock-Exchange Industry: Network Effects, Implicit Mergers, and Corporate Governance, Quaderni di Finanza, March 1999.

Domowitz Ian and Steil Benn (1999): Automation, Trading Costs, and the Structure of the Trading Services Industry, Brookings-Wharton Papers on Financial Services 1999.

Domowitz, Ian (2002): Liquidity, Transaction Costs, and Reintermediation in Electronic Markets, Journal of Financial Services Research, Vol. 22, Iss. 1&2, August/October 2002.

Domowitz, Ian, Glen, Jack and Madhavan, Ananth (2000): Liquidity, Volatility, and Equity Trading Costs Across Countries and Over Time, Working Paper.

Economides, Nicholas (1993): Network Economics with Application to Finance, Financial Markets, Institutions & Instruments, Vol. 2, no. 5, December 1993, 89-97.

Fuerst, Timothy S. (1995): Monetary and Financial Interactions in the Business Cycle, Journal of Money, Credit and Banking, Vol. 27, No. 2, pp 1321-38.

Gehrig, Thomas (1998): Competing Markets, European Economic Review 42 (1998) 277-310.

Gehrig, Thomas (2000): Cities and the Geography of Financial Centers, in The Economics of Cities, edited by Jacques Thisse and J.-M. Huriot, Cambridge University Press, 2000, pp. 415-445.

Greenwald, Bruce, Stiglitz, Joseph E and Weiss, Andrew (1984): Informational Imperfections in the Capital Market and Macroeconomic Fluctuations, American Economic Review, Vol. 74, No. 2, pp 194-9.

Gertler, Mark (1992): Financial Capacity and Output Fluctuations in a Economy with Multi-period Financial Relationships, The review of Economic Studies. Vol.59, No.200, pp 455-472.

Hall, Robert E. (1988): The Relationship between Price and Marginal Cost in U.S Industry, Journal of Political Economy Vol. 96, pp. 921-947.

- Hasan, Iftexhar and Malkamäki, Markku (2000): Are Expansions Cost Effective for Stock Exchanges? A Global Perspective, *Journal of Banking and Finance*, Vol 25, iss. 2, pp 2339-2366.
- Hyde, Charles E. Perloff, Jeffrey M. (1995): Can Market Power Be Estimated? *Review of Industrial Organization*, Vol 10, pp. 465-485.
- King, Robert G. and Levine, Ross (1993): Finance, Entrepreneurship, and Growth, *Journal of Monetary Economics*. Vol. 32, pp. 513-542.
- Laffont, Jean-Jaques, Rey, Patrick and Tirole, Jean (1998): Network Competition: I. Overview and Nondiscriminatory Pricing, *RAND Journal of Economics*, Vol. 29. No. 1 Spring 1998, pp. 1-37.
- Laffont, Jean-Jaques, Rey, Patrick and Tirole, Jean (1998): Network Competition: II. Price Discrimination, *RAND Journal of Economics*, Vol. 29. No. 1 Spring 1998, pp. 38-56.
- Laffont, Jean-Jaques and Tirole, Jean (2000): *Competition in Telecommunications*, MIT Press 2000.
- Laffont, Jean-Jaques, Rey, Patrick and Tirole, Jean (1997): Competition Between Telecommunications Operators, *European Economic Review*, Vol 41, pp. 701-711.
- Levine, Ross (1997): Financial Development and Economic Growth: Views and Agenda, *Journal of Economic Literature*, Vol. 35, June 1997, 688-726.
- Malkamäki, Markku (1999): Are the Economies of Scale in Stock Exchange Activities? *Bank of Finland Discussion Papers 4/1999*.
- Malkamäki, Markku and Topi, Jukka (1999): Strategic Challenges for Exchanges and Securities Settlement, *Bank of Finland Discussion Papers 21/1999*.
- Mason, Robin(2000): Simple Competitive Internet Pricing, *European Economic Review*, Vol. 44(4-6), 2000, pp. 1045-1056.
- McManus, Brian (2002): Nonlinear Pricing in an Oligopoly Market: The Case of Specialty Coffee, *Olin School of Business Working Paper*, March 2002.
- Min, Taeki, Kim, Sang Yong, Shin, Changhoon and Hahn, Minhi (2002): Competitive Nonlinear Pricing With Product Differentiation, *International Review of Economics & Finance*, Vol. 11 (2002) pp. 155-173.
- Miravete, Eugenio and Roller, Lars-Hendrik (2003): Competitive Non-Linear Pricing in Duopoly Equilibrium: The Early US Cellular Telephone Industry, *CEPR Discussion Paper No. 4069*, 2003.

- Mitchell, Bridger M. and Vogelsang, Ingo (1991): Telecommunications pricing: Theory and Practice, Cambridge University Press 1991.
- Oren, Shmuel S. and Smith, Stephen A. (1981): Critical Mass and Tariff Structure in Electronic Communications Markets, *The Bell Journal of Economics*, Vol 12, pp. 467-487.
- Oren, Shmuel S. Smith, Stephen A. and Wilson, Robert B. (1983): Competitive Nonlinear Tariffs, *Journal of Economic Theory*, Vol. 29, pp.49-71.
- Oren, Shmuel S., Smith, Stephen A. and Wilson, Robert B. (1982): Nonlinear Pricing in Markets with Interdependent Demand, *Marketing Science* Vol. 1, No. 3 summer 1982 pp. 287-313.
- Pagano, Marco, Röell, Ailsa and Zechner, Josef (1999): The Geography of Equity Listings: Why Do European Companies List Abroad? CSEF Working Paper 28, October 1999.
- Pankaj, Jain (2002): Institutional Design and Liquidity at Stock Exchanges around the World, Working Paper.
- Panzar, John C. and Rosse, James N. (1987): Testing For "Monopoly" Equilibrium, *Journal of Industrial Economics*, Vol 35, Issue 4, Jun 1987, pp. 443-456.
- Pirrong, Graig (1999): The Organization of Financial Exchange Markets: Theory and Evidence, *Journal of Financial Markets* 2 (1999) 329-357.
- Rajan, Raghuram G. and Zingales, Luigi (1996): Financial Dependence and Growth, NBER Working Paper 5758, September 1996.
- Schmiedel, Heiko (2004): Performance of International Securities Markets, *Bank of Finland Studies E:28/2004*.
- Shy, Oz and Tarkka, Juha (2001): Stock Exchange Alliances, Access Fees and Competition, *Bank of Finland Discussion Papers* 22/2001.
- Steil, Benn (2002): Changes in the Ownership and Governance of Securities Exchanges: Causes and Consequences, *Brookings-Wharton Papers on Financial Services*, 2002.
- Stole, Lars (2003): Price Discrimination and Imperfect Competition, Forthcoming in *Handbook of Industrial Organization*
- Stoll, Hans R. (2001): Market Microstructure, Forthcoming in *Handbook of the Economics of Finance*.
- Suarez, Javier and Sussman, Oren (1997): Endogeneous Cycles in a Stiglitz-Weiss Economy, *Journal of Economic Theory*, Vol. 76, no. 1, September 1997, pp 47-71.

Suominen, Matti (1994): Measuring Competition in Banking: A Two-Product Model, *Scandinavian Journal of Economics*, Vol 96, no. 1 pp.95-110.

Tirole, Jean (1988): *The Theory of Industrial Organization*, MIT Press 1988.

Valletti, Tommaso M. (1998): Two-part Access Pricing and Imperfect Competition, FEEM Working Paper no. 34, 1998.

Vesala, Jukka (1995): Testing for Competition in Banking: Behavioral Evidence from Finland, *Bank of Finland Studies E:1* 1995.

Wilson, Robert B. (1993): *Nonlinear Pricing*, Oxford University Press 1993.

Yin, Xiankang (2004): Two-part Tariff Competition in Duopoly, *International Journal of Industrial Organization*, Vol 22, pp. 799-820.

ESSAY I: Competition between European Stock Exchanges

*(Published in HSE working paper series W-342, ssrn website abstract: 412920
Revised 24.3.2005)*

COMPETITION BETWEEN EUROPEAN STOCK EXCHANGES*

Atso Andersén
Helsinki School of Economics
Department of Economics
P.O. Box 1210
00101 Helsinki, Finland
e-mail: atso.andersen@hkkk.fi
tel. +358-50-3002472

29.3.2005

Abstract

This study focuses on the industrial structure of European stock exchanges and on the level of competition between them from 1995 to 2001. The industrial structure is characterized by analyzing concentration and income structures. A traditional analysis shows that the concentration of European stock exchanges is low. The level of competition is measured at the European level by using a method introduced by Panzar and Rosse (1987). Regression results indicate that at the European level, exchanges operate in monopolistic or perfect competition.

Keywords: Stock exchanges, competition, Europe

JEL Classification: D43; L13; G29

* The author wishes to thank Professor Pekka Ilmakunnas, Professor Otto Toivanen, Professor Pertti Haaparanta and FPPE seminar participants for their comments. All errors are those of the author. The author has received financial support from the Alfred Kordelin Foundation.

Competition between European Stock Exchanges

1 Introduction

Trends like deregulation, internationalization, technological development and investor behavior have all intensified institutional change and the competitive pressures on financial market institutions. Deregulation and the launch of EMU have led to the creation of an increasingly common regulatory basis for capital markets in Europe. Internationalization has brought more international investors to the European markets and technological development has made all this viable. Furthermore, the number of ageing investors will create increased needs for e.g. pension fund management (see ECB 2001 for further analysis).

On the other hand, European exchanges are turning into organizations which aim to maximize profits just like ordinary firms. This change in the corporate governance of stock exchanges justifies analysis of the stock exchange industry using the measures familiar from the industrial organization literature. See Gehrig (1998), Schmiedel (2004), and Malkamäki and Topi (1999) for a comprehensive review of related literature. In addition, Angel (1998), Claessens et al.(2002) and Clayton et al. (2000) study trends and preconditions for equity market structures.

The changing operative landscape and institutional structure are likely to have an impact on the activities of stock exchanges. It is worth asking whether there is yet any evidence of structural change in the European stock exchange industry or of competition between exchanges. That is the objective of this study. The industrial structure is characterized by concentration ratios and revenue structures. The nature of the competition among eight European stock exchanges is analyzed by using the

method introduced by Panzar and Rosse (1987). These exchanges are: Copenhagen, Euronext, Germany, Helsinki, London, Oslo, Stockholm and Swiss exchanges. These exchanges were chosen because of the availability of data. The nature of competition is measured at the European level. Furthermore, institutional factors, such as changes in the number of members, changes in trading systems and changes in structures of lists are taken into the analysis.

Section 2 characterizes the structure of the European stock exchange industry. Section 3 presents a theoretical framework for measuring the level of competition. Section 4 introduces data and estimation results. Section 5 provides concluding remarks.

2 The Industrial Structure of European Stock Exchanges

At the beginning of the 1990s, most European stock exchanges were national institutions and generally considered monopolies. This institutional set-up has changed dramatically during the 1990s. How have these changes in the operational environment of stock exchanges affected the structure of the industry? Hasan and Malkamäki (2000) provide evidence of economies of scale and scope in stock exchanges. To exploit the economies of scale, the concentration of stock exchange activities should increase. Alternatively, it can be argued that national monopolies aim to create fragmented equity markets, which are likely to be less concentrated than would be optimal in the case of an economically integrated Europe. How has the concentration of European stock exchanges developed in the 1990s?

Traditionally, the industrial organization literature studies the structure of an industry by concentration indices. These indices describe the potential level of competition within an industry, even though the ratios do not provide systematic evidence on any other characteristics concerning the industry (see Tirole 1988).

Table 2.

Market shares of exchanges 2001 (domestic companies)

Exchange	Market share based on market capitalisation	Avg. market share based on monthly turnover values
Athens	1.2%	0.7%
Copenhagen	1.1%	0.6%
Deutsche Börse	14.4%	18.0%
Euronext	24.8%	31.8%
Helsinki Exchange	2.6%	2.7%
Iceland	0.1%	0.0%
Irish Exchange	1.0%	0.0%
Italian Exchange	7.1%	11.9%
Lisbon and Oporto	0.6%	0.6%
London	28.9%	20.1%
Luxembourg	0.3%	0.0%
Madrid	6.3%	8.5%
Oslo Bors*	0.9%	0.7%
Stockholmbörsen	3.2%	4.9%
Swiss Exchange	7.1%	na
Vienna	0.3%	0.2%

Data source: Fese

In the case of stock exchanges, market shares based on their market capitalization provides an initial characterization of the industry structure. As shown in Table 1, figures based on 2001 indicate a high level of concentration among the three largest exchanges in Europe. When market shares based on average monthly turnover of domestic stocks are considered, the picture changes slightly. The market shares indicate that share-trading activities are even more concentrated than capitalization. Furthermore, some exchanges seem to be more passive than others with respect to trading in domestic shares. For instance, the market share of share capitalization in London is larger than the market share based on turnover.

When concentration indices are studied over time, the characteristics of the industry become more evident. The level of concentration in the European stock exchange industry is measured by the Herfindahl index, 3-firm and 5-firm concentration ratios during the period from 1990 to 2001¹ (See Table 3). Indices are calculated on the basis

¹ The Herfindahl index is calculated as the sum of the squares of the market shares of the industry.

of market capitalization. According to the Herfindahl index, the level of concentration is low. However, the 3-firm concentration ratio indicates that the three largest exchanges control approximately 70 percent of the market capitalization. The 5-firm concentration ratio underlines the fact that other exchanges are small compared with the three largest ones. The indices also reveal a declining trend during the 1990s, which fits well with the trends of internationalization and technological development, supporting the hypothesis of fragmented stock markets in Europe. It is worth noting that in 2000 and 2001 the declining trend has come to a halt.

Table 3. **Concentration ratios based on market capitalisation**

Year	Herfindahl index (max=1)	3-firm concentration ratio (max 100%)	5-firm concentration ratio (max 100%)
1990	0.209	72.1%	85.1%
1991	0.219	73.7%	86.3%
1992	0.230	75.1%	88.0%
1993	0.221	74.2%	87.5%
1994	0.205	72.0%	86.1%
1995	0.199	70.1%	85.2%
1996	0.197	69.6%	83.1%
1997	0.192	68.3%	83.7%
1998	0.184	67.7%	83.9%
1999	0.181	67.9%	82.4%
2000	0.176	65.9%	82.7%
2001	0.183	68.2%	82.4%

Data source: FIBV

According to the concentration indices, there is no evidence of development towards a more concentrated common European equity market. On the contrary, the evidence suggests that market capitalization of equity markets has geographically spread more evenly among stock exchanges in Europe during the 1990s. This does not support the hypothesis that exchanges exploit economies of scale.

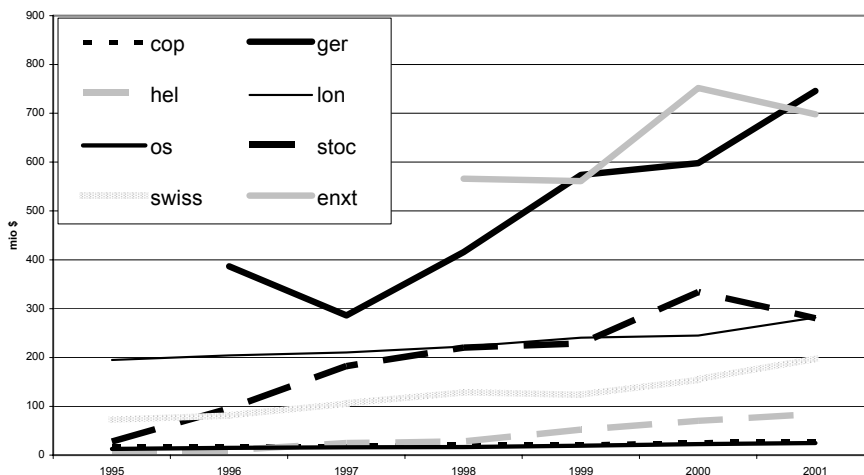
From an institutional perspective, an extensive list of mergers and alliances within the European stock exchange industry provides evidence of increasing co-operation

between stock exchanges (see for instance Shy and Tarkka 2001, Di Noia 1999, Steil 2002 and FIBV Focus). Linkages between exchanges may provide an instrument for liquidity concentration instead of extensive listing migration to the most liquid exchanges.

2.1 Income structures

Data on the revenue structures of stock exchanges give the most explicit characterization of the operative activities. This kind of data is available for stock exchanges of Copenhagen, Euronext, Germany, Helsinki, London, Oslo, Stockholm and Switzerland. These stock exchanges provide various services for customers. Traditionally, the activities of a stock exchange include at least trading services (order book arrangement and matching algorithm), listing services and information dissemination services. Sometimes stock exchanges also provide custody, settlement, outsourcing and other services (system development, consulting etc.) Typically, revenues of stock exchanges consist of trading fees, listing and issuance fees and other income, such as information, communication and IT charges. In recent years, incomes in all the main items have increased as shown in figure 4. Growth has been the clearest in the other revenue item.

Figure 4. **Total revenues of European stock exchanges**



Data source: Annual reports 1995-2001

It is worth noting that stock exchange revenue sources are cyclical by nature as fees are generally connected to trading volumes. However, Tables 4 and 5 show that the structure of revenues has remained stable on aggregate level despite changes in the operative landscape.

The revenue structures indicate that trading fees are the most important source of revenue common to all stock exchanges. Nevertheless, the role of other services has been equally significant. The income structures also show how heterogeneous a group of companies stock exchanges actually are. For instance, in Sweden the stock exchange is merely a subsidiary of a software company. On the other hand, the Swiss Exchange gathers the majority of its income from equity and derivatives trading fees.

Table 4.

Revenue structures of stock exchanges in 1997

Exchange	Trading fees, Listing and total	issuance fees	Sale of information and other income
Copenhagen	37%	36%	27%
Deutsche Börse	53%	7%	40%
Helsinki Exchange	53%	34%	13%
London	30%	15%	54%
Oslo	36%	46%	18%
Stockholm	48%	7%	46%
Swiss Exchange	82%	5%	13%
Total	43%	7%	49%

Data source: Annual reports 1997

It can be argued that the change in industry behavior is partly reflected in the revenue structures. The diversified revenue structures indicate that at least some of the exchanges are adjusting their activities according to the changed operative landscape in order to ensure profitability.

Table 5.

Revenue structures of stock exchanges in 2001

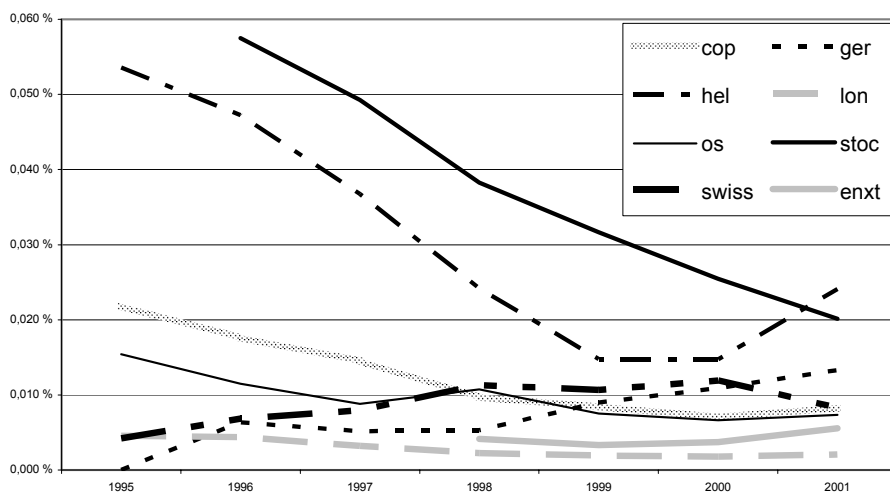
Exchange	Trading fees, Listing and total	issuance fees	Sale of information and other income
Copenhagen	21%	30%	49%
Deutsche Börse	57%	2%	42%
Euronext	37%	7%	55%
Helsinki Exchange	52%	18%	31%
London	33%	16%	50%
Oslo	22%	29%	48%
Stockholm	28%	5%	67%
Swiss Exchange	57%	7%	36%
Total	44%	7%	49%

Data source: Annual reports 2001

Exchanges are increasingly using competitive instruments familiar from strategic interaction between competitive firms like pricing, differentiation and innovation. For instance, there has been a trend-like decrease in the fee income/turnover ratios of the European exchanges as shown in Figure 5. When it comes to the structures of price

schedules of trading services, they are heterogeneous among European exchanges and include components of nonlinear pricing.

Figure 5. **Fee income/turnover –ratios in European exchanges 1995-2001**



Data sources: Annual reports 1995-2001, FIBV

Typically, pricing components for brokers include fee for admission to trade, annual fee for membership, fixed fee for trading, variable fee for trading and discounts (see Appendix 1). In addition, there are numerous other fees related to trading services, such as IT charges. No straightforward conclusions of the nature of competition among the exchanges can be drawn from analyzing pricing structures. However, heterogeneity and nonlinearity indicate that the exchanges potentially have market power in the price setting process due to imperfect competition or because of competition for the high volume customers.

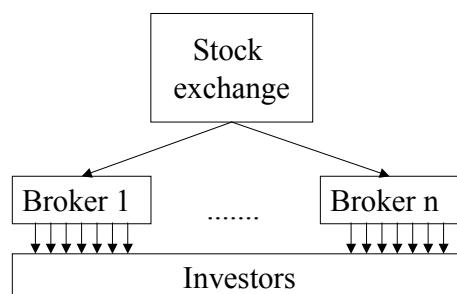
2.2 Vertical structure of the share trading services industry

The industrial structure can be characterized from a vertical perspective as well. In this case, only the vertical structure of share trading services is studied.

When providing share trading services, stock exchanges are seldom directly connected to end-customers (see Domowitz and Steil 1999, and Domowitz and Lee 1998). Typically, the existing industry structure in Europe includes brokers who are direct customers of the exchange. Brokers provide share trading and other services for their customers, investors. Ultimately, investors can be considered as the final customers of stock exchanges. Brokers can be seen as intermediaries, even though in the case of proprietary trading they act as end customers.

The traditional vertical structure of the share trading industry as a whole can be interpreted as an entity where the stock exchange operates as a monopoly and brokers represent retailers of trading services (see Figure 6). Exchanges have usually had several retailers who have provided differentiated trading services for end-customers. Hence, this vertical industry structure represents intra-brand competition in the industrial organization literature (see Tirole 1988).

Figure 6. **The traditional structure of the share trading industry**



As Domowitz and Steil (2002) argue, technological development has made the division between exchanges and brokers increasingly artificial. Some exchanges² provide trading services directly to end-customers. This trend is likely to become more common also in other countries where stock exchange activities are based on automated order-driven trading systems.

Due to changes in the European market structure, the broker level of the distribution channel is increasingly competitive. In the case of exchanges, the numbers of cross-members and cross-listed companies are also increasing competition. Therefore, the traditional vertical structure of share trading industry has also changed. Previously monopolistic institutions face an increasingly competitive environment at all levels of the vertical value chain.

Change in the vertical industry structure is likely to have many consequences. Most importantly, the discussion of maximizing an aggregate industry profit among brokers and exchanges should change into competition between exchanges (see Gehrig 1998, Pagano et al. 1999) and between brokers and exchanges.

2.3 Institutional factors in stock exchange competition

It was noted above that exchanges potentially face increasing competition. According to the industrial organization literature such a situation could lead to a need to differentiate provided services. Is this the case with stock exchanges?

Di Noia (1999) and Pankaj (2002) argue that exchange-specific institutional factors have had an impact on stock exchange behavior, market functionality and the level of competition between exchanges. Therefore, differentiation would be expected. The

² For instance, Stockholm Stock Exchange and Copenhagen Stock Exchange.

following institutional changes were common in European stock exchanges of the end of the 1990s:

- Mergers and acquisitions,
- Changes in the trading system,
- Changes in the number of members,
- Changes in the number of quoted companies,
- Changes in the structure of lists,
- Extension of trading hours and
- Changes in stock exchange ownership structures

Next each of these factors is discussed briefly. In sum, it can be argued that there are signs that contradict the hypothesis of service differentiation. Exchanges merely support a tendency towards more a unified manner of providing trading services.

Mergers and acquisitions

Recently several horizontal mergers and co-operation agreements have been concluded between European stock exchanges. In addition, stock exchanges have continued to merge with derivative and future exchanges³. Value chain integration has also progressed, as stock exchanges and securities settlement houses have merged⁴. Mergers and acquisitions can be categorized into three separate subsets: vertical, geographical (horizontal), and activities-based consolidation. Vertical mergers exploit value-chain economies. This is the case when securities settlement institutions and stock exchanges consolidate. Geographical mergers exploit the idea of scale economies in stock trading.

³ Euronext and Liffe, for instance.

⁴ Deutsche Börse and Clearstream, for instance.

Activities-based mergers take advantage of the potential scope economies in providing trading of a suitable set of financial instrument.

Arnold et al. (1999) showed that mergers of regional exchanges have positively contributed to their market share of value of trades in the United States in the 1950s. It is still too early to analyze the situation in Europe. However, the set-up is potentially similar.

Changes in trading systems

During the 1990s the majority of European exchanges had finally transferred to automated order driven trading systems.

In the literature the impact of trading systems on liquidity and volume of share trading has been studied in several papers (see Pankaj 2002, Domowitz 2002, Domowitz et al. 2000, and Domowitz, Steil 1999). It is argued that the more developed and stable the trading systems are the more liquid and well functioning the markets become.

Changes in the number of members

After the implementation of the Investment Services Directive, the remote memberships of brokers in European stock exchanges have increased. The allowance of remote memberships has altered the way brokerage activities are conducted. International brokers have direct access to local stock exchanges. Previously, international brokers were operating through local brokers and financial intermediaries. Cross-memberships in several stock exchanges enable brokers to choose the most liquid marketplace and make stock exchanges compete.

This phenomenon is also characterized in the literature. For instance, Shy and Tarkka (2001) and Di Noia (1999) show, in theoretical set-ups, that remote access intensifies competition between stock exchanges.

Changes in the number of quoted companies and changes in the structure of lists

The number of listed companies has also increased steadily during the last decade. In order to respond to the trend, stock exchanges actively established "new technology" lists at the end of the 1990s. However, trading activity on these lists has been mixed and it seems that ensuring sufficient liquidity for newly listed technology companies has become increasingly difficult. In some cases, the establishment of these lists enabled the stock exchanges to list companies that were not suitable for main lists. Hence, stock exchanges were able to reach a new group of companies for trading.

Furthermore, international companies increasingly list their shares around the global stock exchanges, intensifying the competition for liquidity further (See for instance Pagano et al. 1999).

Extension of trading hours

Several stock exchanges have extended trading hours in order to capture market share of stock trading in cross-listed shares. However, the resistance of local brokers has forced stock exchanges to pull back extended trading hours in some cases (see FIBV Focus 2003/19).

Changes in stock exchange ownership structure

Ownership structures of European stock exchanges have changed considerably during the past few years. Several exchanges have “demutualized” and even listed⁵. This trend is clearly divergent from the United States, where exchanges have not listed. It is worth noting that listing has been common especially with exchanges using automated order-driven matching technology (see Domowitz and Steil 1999).

As Steil (2002), Pirrong (1999, 2000) and Domowitz and Steil (1999) argue, the governance of the stock exchange has a major impact on the operation of the exchange. Formerly stock exchanges were typically co-operatives formed by the local brokers or mainly broker-owned demutualised exchanges. Listing is likely to alter the formerly strong connection between brokers and stock exchanges. Furthermore, diversified owners should emphasize the objective of profit maximization.

2.4 Is there one European stock market, after all?

There are arguments for and against the idea of one common stock market in Europe. Evidence for cross-listings of European firms in particular is presented by Pagano et al. 1999.

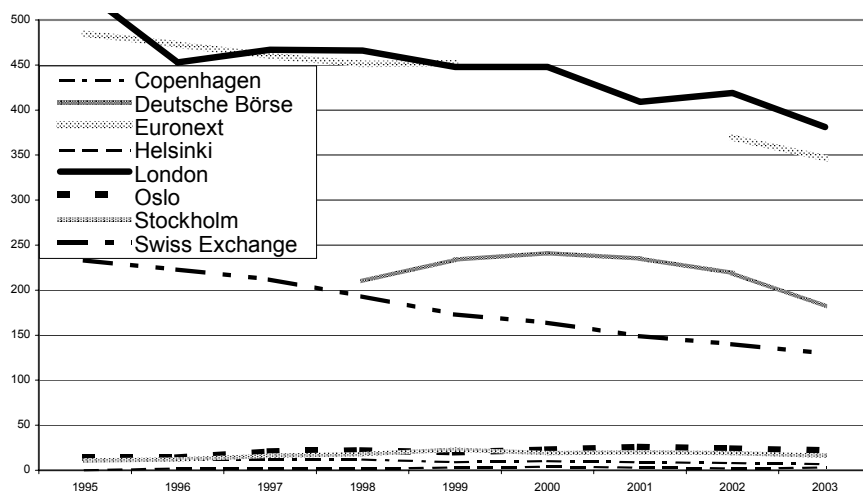
In the case of the Helsinki stock exchange, Andersen (2005) presents evidence of increasing international ownership, number of remote brokers and market share. All this evidence justifies the assumption that international investors have increasingly easier access to such a distant stock market as Finland. Furthermore, the institutional changes listed above illustrate how European stock exchanges are actually trying to

⁵ For instance, the creation of Euronext created demutualization of exchanges of Paris, Amsterdam and Brussels in 2000. Also, the exchange of Athens demutualized in 2000. Deutsche Börse and Oslo Börs were listed in 2001. London exchange was listed 1997. Stocholmbörsen was demutualised as a result of a merger with OM in 1998.

homogenize their trading arrangements in order to decrease costs of trading on common European market.

However, the case of common market is not likely to be straightforward. When it comes to the number of foreign companies in European stock exchanges, recent development indicates declining interest in foreign listings (see Figure 7). This may be due to the easier access of investors to local exchanges or it may illustrate the fact that firms have not found it worthwhile to list their stocks abroad. However, it is worth noting that this brief evidence is also subject to other factors, such as delistings (i.e. firms' withdrawal from exchange in general).

Figure 7. **The number of foreign companies in the European stock exchanges**



Data sources: FIBV, FESE

There are also arguments against the idea of a common European equity market. First, the regulation faced by each stock exchange differs, as national legislation is still heterogeneous among European countries. Second, institutions providing trading

services are also heterogeneous as can be seen from revenue structures above. Third, some of the stock exchanges handle other tasks related to trading, such as clearing and settlement activities.

Hence, it is difficult to find a definitive answer to the question of the existence of a common European stock market. In this study, however, the point of departure is the assumption that there is one common European stock market and competition is analyzed accordingly. In order to verify whether results are consistent on a local level, the competition faced by each exchange over time is also analyzed separately.

3 A theoretical framework for measuring the level of competition

The arguments presented above suggest that there is potential competition between European stock exchanges. Next, it will be examined whether there is any evidence of such competition.

The analysis of competition between stock exchanges in this paper is measured according to the NEIO-approach⁶, which focuses on the role of the competitive conduct between companies. More particularly, the model of Panzar and Rosse (1987) is applied to construct an indicator measuring the nature of competition in the European stock exchange industry. The Panzar and Rosse model has been widely used in analysing European banking sectors (see for instance, Bikker and Haaf, 2002 and De Bandt and Davis, 2000). These studies provide a suitable background for applying the model to the stock exchange industry.

The Panzar and Rosse method is applied because of its evident strengths: simplicity and reasonable data requirements. It is worth emphasizing that it suffers from some

⁶ New Empirical Industrial Organization (see Bresnahan 1989).

potential weaknesses. According to Hyde and Perloff (1995), the approach used is powerless in the case of specification of cost function based on Cobb-Douglas technology. Secondly, they argue that the approach is in general sensitive to the functional form of the estimated equation and the factors included.

The relevant market for the study consists of stock exchanges providing transaction services to brokers and investors in Europe. Generally, the spatial restrictions of a market are determined by contacts between market participants. It can be argued that recent changes in technology and regulation have decreased these restrictions on transaction services provided by European stock exchanges. This justifies the following analysis. Nevertheless, the European stock exchanges have unique national features arising from their activities, role in society, and traditions. These differences are also analysed by studying each stock exchange separately.

Basically, the Panzar and Rosse -model introduces an indicator to measure competition in the cases of monopoly, oligopoly and competitive markets. The indicator is a sum of the factor-price elasticities of the revenues. The model assumes that the companies studied maximize profit. The model also uses a reduced form revenue equation to describe the activities of companies. Initially, the revenues of the exchanges are assumed to be independent of rivals' (actual or potential) actions and if the hypothesis is rejected, it is interpreted as a sign of some level of competition.

Following Panzar and Rosse (1987), Vesala (1995), Bikker and Haaf, (2002) and De Bandt and Davis, (2000) an exchange maximizes its profits when marginal revenue equals marginal costs:

$$(1) \quad R'_i(x_i, n, z_i) - C'_i(x_i, w_i, t_i) = 0$$

where

$R'_i =$	Marginal revenues of exchange i
$x_i =$	The output of exchange i
$z_i =$	Exogenous variables that shift the exchange's revenue function
$n =$	The number of rivals
$C'_i =$	Marginal costs of exchange i
$w_i =$	Vector of m factor input prices of exchange i
$t_i =$	Exogenous variables that shift the exchange's revenue function

The market power is measured as a relationship between the changes in factor input prices and the change in equilibrium revenue earned by the exchange i . Consequently, Panzar-Rosse statistic is defined as:

$$(2) \quad H = \sum_{k=1}^m \frac{\partial R_i}{\partial w_{k_i}} \frac{w_{k_i}}{R_i}$$

Where m denotes the set of factor of input prices. According to the Panzar and Rosse - model, an increase in input prices will increase marginal costs, decrease output and reduce revenues in the case of monopoly. Therefore, the values of H are zero or negative. The article of Panzar and Rosse (1987) also studies monopolistic competition, perfect competition and conjectural variation oligopoly. On the basis of their results, H gets values equal or under 1 under monopolistic competition. In the case of perfect competition H equals 1.⁷ Values of H greater than 1 imply the rejection of all three

⁷ See Panzar and Rosse (1987) and Bikker and Haaf (2002) for further details.

models. This indicates that the underlying structural model could not be identified. Table 5 summarizes the interpretation of H values.

Table 6. **Interpretation of H values**

Values of H	Competitive environment
$H \leq 0$	<i>Monopoly equilibrium.</i>
$0 < H < 1$	<i>Monopolistic competition.</i>
$H = 1$	<i>Perfect competition.</i>

3.1 A specification of the empirical model

The specification of the empirical model is based on Bikker and Haaf (2002, pages 2195-2197) and DeBandt and Davis (2000). These specifications have been used to assess financial services industries. Even though the operations of financial services industries differ from those of the stock exchange industry, the framework provides a good basis for estimations. There are other sources of incomes that are considered as in Bikker and Haaf (2002) and as DeBandt and Davis argue, the loglinear specification may also reduce any simultaneity bias in estimations. The following specification for the revenue equation will be used in estimations:

$$(3) \quad \ln TR_{it} = \alpha + \beta \ln PE_{it} + \gamma \ln OE_{it} + \sum \zeta_l \ln ESF_{mit} + \tau \ln LS_{it} + \eta \ln OI_{it} + e_{it}$$

where

TR_{it} = Trading revenues

PE_{it} = Input price of personnel

OE_{it} = Input price of system operation

ESF_{mit} = Exchange specific factors

LS_{it} = Listing fees

$$OI_{it} = \text{Other operating income (}/\text{the ratio to the value of turnover)}$$

In the equation (7), the H statistics is determined by $\beta + \gamma$.

The original model of Panzar and Rosse (1987) does not state any specific requirements for variables. Naturally, in the optimal case, precise marginal revenue and input price variables would be available. However, this is rarely the case and this study is no exception. Data on input price variables was not available. In such a case, either scaled or unscaled variables of returns and costs based available information have been used to proxy the contents of theoretically optimal variables (see Vesala 1995 and Bikker and Haaf 2002). The objective of scaling is to proxy for factor prices. In this study, the model will be estimated with and without scaling. Scaling will be based on the value of total turnover. Scaling of cost variables by the value of turnover proxies input prices. In the case of personnel expenses, scaling is also done by using the average number of employees, in order to proxy the input price of personnel.

Exchange specific factors ESF_{mi} consist of variables specific but exogenous to both marginal revenue and marginal costs functions. Exchanges specific factors include variables such as changes in trading systems, changes in the number of members, changes in the structure of lists. These changes represent cost and revenue shifters.

Listing fees and other operating income are included in the model, since these items may shift the revenue schedule. Their role is likely to be significant as can be verified from the illustration of income structures. The analyzed exchanges conduct varied operations. Some generate majority of revenues from other activities such as clearing and settlement whereas some exchanges have focus on providing trading services only. Moreover, there are likely to be country specific differences and institutional changes

that have not been included into the model. In order to avoid inaccuracy, yearly dummies $YEAR_i$ are added into the specification:

$$(4) \quad \ln TR_{it} = \alpha + \beta \ln PE_{it} + \gamma \ln OE_{it} + \sum \zeta_{lit} \ln ESF_{lit} + \tau \ln LS_{it} + \eta \ln OI_{it} + \psi YEAR_{it} + e_{it}$$

Macroeconomic factors are controlled by including the GDP variables of countries of origin of the exchanges. The stock exchange indices are included to take account of the general level of activity in European stock markets, which is a revenue shifter. Definitions of used variables are reported in the Table 7.

Table 7. **Definitions of variables**

Variables	Definition	Details
Dependent variable:	Trading revenues (TR)	Annual data on trading and transaction fees in the main equity market of the exchange
Independent variables:	Personnel expenses (PE)	Annual data on personnel expenses
	Personnel expenses/ value of turnover	
	Personnel expenses/ average number of employees	
	Operating expenses (OE)	Annual data on other operating expenses including depreciation
	Operating expenses/ value of turnover	
	Listing fees (LS)	Annual data on listing fees
Exchange specific variables (ESF):	Listing fees/ value of turnover	
	Other operating income (OI)	Annual data on sale of information, IT-services, consulting services and other income
	Other operating income/ value of turnover (OI)	
Control/other variables	Changes in trading systems	Dummies for changes in trading systems
	Number of members	Annual data on the number of members
	Changes in the structure of lists	Dummies for list change
	Exchange's indices	Annual index values
	GDP of exchange's country of origin	Annual inflation rates
	Trend dummy	A time dummy

The industry level changes in the competitive environment are studied by applying the model to a panel of European stock exchanges.

4 Empirical estimation results

4.1 Data

An unbalanced panel data set covers the period from 1995 to 2001. The data set for the study was gathered from several sources. The main sources of information are the FIBV monthly publications Focus, Salomon Smith Barney/LGT/Euromoney Guide to World Equity Markets and annual reports of exchanges.

In the panel estimation, yearly observations were used. The number of observations is 48. Admittedly, the manually collected data set is scarce but it still allows the following statistical analysis.

Table 8. **Exchanges and sample years**

<u>Exchange</u>	<u>Years</u>
Copenhagen	1995-2001
Deutsche Börse	1996-2001
Euronext	1998-2001
Helsinki Exchange	1995-2001
London	1995-2001
Oslo	1995-2001
Stockholm	1995-2001
Swiss Exchange	1995-2001

It seems that the size of the exchange as well as the ownership structure affects the availability of data. Other shortcomings related to the data set are common in all industrial organization analysis. Most importantly, the figures are based on profit and loss accounts that follow national accounting standards. Nevertheless, the data set is the most comprehensive available for characterizing the level of competition between European stock exchanges. Descriptive statistics are presented in Table 9.

Table 9.

Descriptive statistics for the panel variables 1995-2001

	Trading revenue, Mio USD	Personnel expenses, Mio USD	Number of employees	Number of members	Other expenses, Mio USD	Listing fees, Mio USD	Other income, Mio USD	Turnover, Mio USD
Mean	56.99840	44.47471	548.17307	114.10638	111.7469	6.85512	87.90224	984147.1
Median	50.60927	38.20008	303.50000	45.00000	57.30085	0.70951	25.18386	316795.8
Maximum	231.9031	199.0000	2096.0000	431.0000	458.0791	9.80000	424.0000	4900274.
Minimum	3.846093	4.861407	39.000000	21.00000	7.445901	.705093	1.666885	24942.34
Std. Dev.	55.66714	46.16443	565.49099	127.69158	123.7621	5.06795	110.1531	1372276.
Skewness	1.245820	1.493283	1.1646700	1.28846	1.201440	.420583	1.461153	1.576729
Kurtosis	4.258552	4.906771	3.4494600	3.08785	3.504733	3.926124	4.359804	4.320510
Jarque-Bera	15.58444	25.11070	12.19380	13.01964	12.05717	17.85986	20.77787	23.37610
Observations	48	48	48	47	48	48	48	48
Cross sections	8	8	8	7	8	8	8	8

4.2 The exchange industry estimations

The analysis of the whole exchange industry is conducted by using a fixed effect model with cross-sectional weights for panel data. This is done because there may be exchange specific and structural factors that are omitted from estimations. Fixed effects are applied to take account of exchange-specific factors, which may have impact on inference. In control estimations yearly dummies are introduced to take account of potential structural changes over time. This approach follows the method applied by DeBandt and Davis (2000).

The panel level estimation is based on the hypothesis that equity markets in Europe are integrated and that investors and brokers can choose between different stock exchanges. In addition, trading services as such are assumed standardized even though listed companies differentiate the actual subject of the service. As argued above, the level of differentiation in this respect is diminishing. Another caveat arises from the input markets. The exchanges do not necessarily have access to the same pool of factors of

production. This is not so much of a problem in the other expenses (including trading system related costs) as it is in the case of personnel expenses. However, panel estimation can be considered to represent the European average. Moreover, yearly dummies are included to control for potential impact of this kind of factors. It is assumed that the industry is operating in equilibrium, which justifies use of the Panzar and Rosse model. Furthermore, the estimation is based on the assumption of profit maximizing exchanges. On the basis of these caveats and the fact that fully optimal data is not available estimation procedure includes several robustness checks.

In the estimation, the cross-sectional weights were used in order to control for heteroskedasticity. In particular, the weights for fixed effect FGLS estimation were based on estimated cross-section residual variances. The residual variances were estimated in the first stage pooled OLS estimation. Multicollinearity is not found problematic in the data set⁸. However, some estimations suffer from autocorrelation according to Durbin-Watson test-statistics. Table 10 includes estimation results.

The H -indicator consists of the sum of coefficients for personnel and other expenses. For exchanges in the panel, the average value of H -indicator is 0,7060. According to Wald-tests in different estimations, the indicator is mainly significantly different from zero (the value of zero would indicate collusion). However, when the difference from one is tested, only two estimations indicate a significant difference from one (the value one would indicate perfect competition). The evidence suggests that i) the null that exchanges are monopolies can be rejected and ii) competition between exchanges is either perfect or monopolistic.

⁸ Excluding insignificant variables did not lead to change in the sign of significant coefficients.

Table 10.

Panel estimation results for years 1995-2001

Dependent Variable: Total revenues							
Method: FIXED EFFECTS FGLS (weighted), YEAR DUMMIES							
Independent Variables	Estimation 1	Estimation 2	Estimation 3	Estimation 4	Estimation 5	Estimation 6	Estimation 7
<i>PE/turnover</i>	-0,4082						
	<i>0,3896</i>						
<i>PE/number of personnel</i>		0,6070***		0,5991***	0,7247***	0,5555***	0,6070***
<i>PE</i>		<i>0,2043</i>	0,0257	<i>0,1632</i>	<i>0,1663</i>	<i>0,1514</i>	<i>0,2044</i>
			<i>0,3265</i>				
<i>OE/turnover</i>	1,0517***	0,1027		0,1660	-0,0342	0,0431	0,1027
	<i>0,3617</i>	<i>0,1887</i>		<i>0,1141</i>	<i>0,1501</i>	<i>0,1091</i>	<i>0,1887</i>
<i>OE</i>			0,7991**				
			<i>0,3125</i>				
<i>LS/turnover</i>	-0,0712						
	<i>0,1362</i>						
<i>LS</i>		0,1866	0,1964	0,1717	0,1219	0,0567	0,1866
		<i>0,1667</i>	<i>0,1406</i>	<i>0,1476</i>	<i>0,1383</i>	<i>0,1589</i>	<i>0,1667</i>
<i>OI/turnover</i>	-0,5201***						
	<i>0,1612</i>						
<i>OI</i>		0,0031	-0,4616***	-0,0782	0,0249	0,0569	-0,0031
		<i>0,1293</i>	<i>0,1391</i>	<i>0,1015</i>	<i>0,099</i>	<i>0,0955</i>	<i>0,1293</i>
<i>Index</i>				0,0000			
				<i>0,0000</i>			
<i>GDP</i>					-1,5001*		
					<i>0,7799</i>		
<i>Automation</i>						-0,3812***	
						<i>0,1255</i>	
<i>List change</i>						0,0105	
						<i>0,1389</i>	
<i>Number of members</i>							0,2003
							<i>0,3567</i>
H-statistic	0,6435	0,7096	0,8248	0,7651	0,6906	0,5986	0,7097
<i>Wald test H=1</i>	*					**	
<i>Wald test H=0</i>	***	***	***	***	***		**
<i>Durbin-Watson</i>	1,3215	1,7493	1,5420	1,8648	1,8454	2,0033	1,7493
<i>R²</i>	0,994	0,980	0,993	0,997	0,997	<i>0,999</i>	<i>0,980</i>

Standard errors are reported in italic. ***, **, * portray significance at the 1,5,10 percent levels respectively. In Wald tests $H=0$ or $H=1$ is rejected at the 1,5,10 percent significance levels reported as ***, **, * respectively.

A major contributor for the H -indicator is personnel expenses even though trading systems are heavily dependent on system investments. Notably, the coefficient for other expenses is statistically insignificant in the most of the estimated cases.

The listing revenues have contributed positively to trading income whereas other revenues seem to have a negative impact.

Hence, exchanges have not succeeded to raise trading activity by providing additional services. Nevertheless, these services are often indirectly related to trading activity (e.g. increased sales of market information do not directly contribute to trading revenues). Estimation results also indicate that the impact of technical changes in the trading systems has been negative. The impacts of changes in the structure of lists and in the number members have been insignificant.

5 Concluding remarks

A characterization of European stock exchanges is presented in this article by using means familiar from traditional industrial organization literature. According to the used framework, the stock exchange industry is not very concentrated at the European level. When it comes to the vertical structure of the share trading services, the industrial structure and objectives have changed due to demutualisation and competition between exchanges. European exchanges have more and more characteristics of profit-maximizing firms.

The nature of competition between European stock exchanges was measured using a method introduced by Panzar and Rosse (1987). The measure is based on the revenue elasticities of inputs in reduced form revenue function. The estimation results indicate that there is evidence of monopolistic or perfect competition between stock exchanges

during the period from 1995 to 2001. The impact of technical changes in the trading systems on trading revenue was found to be negative. However, other institutional factors such as changes in the structures of lists and the contribution of an increase in number members have had an insignificant impact on trading revenues.

References

- Andersen, Atso (2005): Assessing Demand and Pricing of Stock Exchange Trading Services, Unpublished manuscript, Helsinki School of Economics.
- Angel, James J. (1998): Consolidation in the Global Equity Market, Working Paper, Georgetown University.
- Arnold, Tom, Hersch, Philip, Mulherin, Harold J. and Netter, Jeffrey (1999): Merging Markets, *Journal of Finance*, Vol LIV, No. 3, June 1999, 1083-1107.
- Bikker, Jacob A. and Haaf, Katharina (2002): Competition, Concentration and Their Relationship: An Empirical Analysis of the Banking Industry, *Journal of Banking and Finance* Vol 26, 2002, pp. 2191-2214.
- Bresnahan, Timothy (1989): Empirical Studies of Industries with Market Power, In *Handbook of Industrial Organization*, Vol II, edited by R. Schmalensee and, R.D. Willig, Elsevier Science Publishers 1989.
- Claessens, Stijn, Klingebiel, Daniela and Schmukler, Sergio L. (2002): The Future of Stock Exchanges in Emerging Economies: Evolution and Prospects, in Robert E. Litan and Richard Herring (Eds.), *Brookings-Wharton Papers on Financial Services 2002*, The Brookings Institution, Washington, D.C., 167-212.
- Clayton, Matthew J., Jorgensen, Bjorn N. and Kavajecz, Kenneth A. (2000): On the Formation and Structure of International Exchanges, New York University Working Paper 00-008.
- Copenhagen Stock Exchange: Annual reports 1996-2001.
- Deutsche Börse: Annual Reports 1996-2001.
- DeBandt, Olivier and Davis, E. Philip (2000): Competition, Contestability and Market Structure in European Banking Sectors on the Eve of EMU, *Journal of Banking and Finance* Vol 24, 2000, pp. 1045-1066.
- Di Noia, Carmine (1999): The Stock-Exchange Industry: Network Effects, Implicit Mergers, and Corporate Governance, *Quaderni di Finanza*, March 1999.
- Domowitz, Ian (2002): Liquidity, Transaction Costs, and Reintermediation in Electronic Markets, *Journal of Financial Services Research*, Vol. 22, Iss. 1&2, August/October 2002.
- Domowitz, Ian, Glen, Jack and Madhavan, Ananth (2000): Liquidity, Volatility, and Equity Trading Costs Across Countries and Over Time, Working Paper.
- Domowitz, Ian and Steil, Benn (1999): Automation, Trading Costs, and the Structure of the Trading Services Industry, *Brookings-Wharton Papers on Financial Services* 1999.

Domowitz, Ian and Lee, Ruben (1998): The Legal Basis for Stock Exchanges: The Classification and Regulation of Automated Trading Systems, Working Paper, Northwestern University.

EURONEXT: IPO Information.

European Central Bank (2001): European Equity Markets, ECB Euro Equity Markets Report, August 2001.

FESE: Monthly Statistics 2000-2001.

FIBV: Monthly Statistics 1995-2001.

FIBV: Focus, Monthly Publication 1997-2001.

Gehrig, Thomas (1998): Competing Markets, European Economic Review 42 (1998) 277-310.

Hasan, Iftexhar and Malkamäki, Markku (2000): Are Expansions Cost Effective for Stock Exchanges? A Global Perspective, Journal of Banking and Finance, Vol 25, No. 12, pp. 2339-2366.

Helsinki Stock Exchange: Annual Reports 1995-2001.

Hyde, Charles E. and Perloff, Jeffrey M. (1995): Can Market Power Be Estimated? Review of Industrial Organization, Vol 10, pp. 465-485.

LGT: Guide to World Equity Markets 1997, Euromoney Publications 1997.

London Stock Exchange: Annual Reports 1996-2002.

Malkamäki, Markku and Topi, Jukka (1999): Strategic Challenges for Exchanges and Securities Settlement, Bank of Finland Discussion Papers 21/1999.

OM - Stockholm Stock Exchange: Annual reports 1997-2001.

Oslo Stock Exchange: Annual Reports 1996-2001.

Pagano, Marco, Röell, Ailsa and Zechner, Josef (1999): The Geography of Equity Listings: Why Do European Companies List Abroad? Journal Finance, Vol. 57, No. 5, pp. 2651-2694.

Pankaj, Jain (2002): Institutional design and Liquidity at Stock Exchanges around the World, Working Paper, University of Memphis.

Panzar, John C. and Rosse, James N. (1987): Testing For "Monopoly" Equilibrium, Journal of Industrial Economics, Vol 35, Issue 4, Jun 1987, pp. 443-456.

Pirrong, Graig (2000). A Theory of Financial Exchange Organization, Journal of Law and Economics Vol. XLIII (October 2000).

Pirrong, Graig (1999): The Organization of Financial Exchange Markets: Theory and Evidence, Journal of Financial Markets 2 (1999) 329-357.

Salomon Smith Barney: Guide to World Equity Markets 2000, Euromoney Publications 2000.

Schmiedel, Heiko (2004): Performance of International Securities Markets, Bank of Finland Studies E:28/2004.

Shy, Oz and Tarkka, Juha (2001): Stock Exchange Alliances, Access Fees and Competition, Bank of Finland Discussion Papers 22/2001.

Steil, Benn (2002): Changes in the Ownership and Governance of Securities Exchanges: Causes and Consequences, Brookings-Wharton Papers on Financial Services, 2002.

SWX – Swiss Stock Exchange: Annual reports 1996-2001.

Tirole, Jean (1988): The Theory of Industrial Organization, MIT Press 1988.

Vesala, Jukka (1995): Testing for Competition in Banking: Behavioural Evidence from Finland, Bank of Finland Studies E:1 1995.

Appendix 1 Price schedules for matching services in European exchanges 2002

	Switzerland	Oslo	Copenhagen	Vienna
Fixed fee for admission	25000 CHF	-	-	-
Fee for membership	10 000 CHF per year	200 000 NOK per year	-	Official mkt; 0,50 bps (min 2175€ max 10750€) Semi-official mkt; 0,25bps (min 1075€ max 5450€)
Other fees	-	-	If the total annual fee payable to the exchange for share trading does not exceed DKK 200 000, a minimum fee of DKK 200 000 is payable	The fees for trading passes (assigned trades) is 70 EUR per year for employees of member firms and 100 EUR for other traders (assistants)
Fee based on number of trades	Own account trades: A monthly fee based on turnover - bonus. Monthly fee structure: fixed fee+percentage of turnover-bonus.	4,00 NOK per transaction	Primary party 2,44 per trade, Secondary party 4,10 per trade, Off-exchange 4,10 per reported trade (due to primary party)	-
Fee based on value of trades	0,1 CHF per each 1000 CHF in turnover (based either on market value or final settlement value) for customer transactions, transactions between securities dealers are not subject to the turnover fee Own account trades: -100 000; 3,5+0,0035% -200 000; 6,9+0,00345% -300 000; 10,10+0,00337% -400 000; 13,10+0,00328% -500 000; 15,90+0,00318% -600 000; 18,50+0,00308% -700 000; 20,70+0,00296% -800 000; 22,30+0,00279% -900 000; 23,30+0,00259% ->1 000 000; 24,00+0,00240%	20 NOK per 1 mio in turnover, min total fee: -0-50 000NOK; 5,00 -50 000-100 000NOK; 7,50 -100 000-500 000NOK; 12,50	Primary party 28 DKK per 1 mio in value, Secondary party 42 DKK 1 mio in value, Off-exchange 42 DKK per 1 mio in value	Fees per trade: Agent; 4 bps (min 1,8€ max 90€) Principal; 4 bps (min 1,8€ max 90€) Market Maker; 2 bps (min 1,8€ max 36€) Standard Market; 6 bps (min 3,6€ max na. €)
Discounts	Own account trades: Bonus is equal to the maximum deduction (30% of full fees) weighted by the respective customer share as %.	-	Maximum fee 400 DKK per trade. Discount on value-based fees: -less than 60 000; 0% -110 000; 5% -160 000; 10% -210 000; 15% -260 000; 20% -310 000; 25% -360 000; 30% -410 000; 35% -460 000; 40% -510 000; 45% -more than 510 000; 50%	-

	Germany (XETRA)	Helsinki	London	Euronext
Fixed fee for admission	-	21 700 €	-	-
Fee for membership	-	1 750€ per month	SEAQ; £20 000 per year, - SEAQ Plus; £5 000, SEAQ Int.:£7 000	-
Other fees	-	-	Order entry 1p, order deletion 1p	Order entry 0,3€, any order placed 2 minutes before or after opening or closing of the session 0,75€
Fee based on number of trades	High volume; 20 000€ per month, premium 0% Medium volume; 5 000€ per month, premium 5% Low volume; 2 000€ per month, premium 15%	PRICE LIST I: first 10 000 trades/month 1,47€ per trade then 0,88€ per trade PRICE LIST II: 0,58€ per trade	5p per automatically matched trade for both parties	Monthly trades less than -10 000;1,05€ per trade -20 000 trades;1,94€ -40 000 trades;1,68€ -60 000 trades;1,39€ -80 000 trades;1,10€ -100 000 trades 0,78€ -200 000 trades;0,60€ -400 000 trades;0,55€ -more than 400 000 trades;0,40€ per trade
Fee based on value of trades	0,56 bps (min 0,7€ max 21€)	PRICE LIST I: Automated trade 0,00244%, Negotiated trade 0,00325%, After market 0,00325% PRICE LIST II: Automated trade 0,00313%, Negotiated trade 0,00411%, After market 0,00411%	1) Trades autom. executed during cont. trading: 8p per £1 000 (min £25 max £12,50) paid by aggressor 2) Trades autom. executed during the auction or crossing process: 8p per £1 000 (min £25 max £12,50) paid by both parties	-
Discounts	Premium in Medium and Low volume categories is calculated on the value based transaction price	-	-	-

**ESSAY II: Pricing of Stock Exchange Trading – The Role of
Network Externalities**

(Unpublished)

PRICING OF STOCK EXCHANGE TRADING – THE ROLE OF NETWORK EXTERNALITIES*

Atso Andersén**

9.2.2005

Abstract

The objective of the article is to develop a three-layer spatial model of trading services. The model presents a monopoly exchange and interaction between two brokers providing trading services to investors in an uncovered market. A case of investor-level network externality is examined. It was found that there is interaction between brokers due to externality effect even though they are local monopolies. Three different vertical industry structures were analyzed: no collusion, collusion between brokers and vertically integrated industry. The vertically integrated structure results in the lowest fees and the highest demand as well as the highest profits for brokers.

Keywords: Stock exchange, trading services, competition, nonlinear pricing, network externality, vertical integration
JEL Classification: D43; L13; L22; G29

* The author wishes to thank Pekka Ilmakunnas, Otto Toivanen, Ville Aalto-Setälä, Juuso Välimäki and Robin Mason for their comments. All errors are those of the author. The author has received financial support from Yrjö Jahnsson Foundation and Research Foundation of Savings Banks.

** Helsinki School of Economics, Department of Economics, P.O. Box 1210, 00101 Helsinki, Finland, e-mail: atso.andersen@hkkk.fi, tel. +358-50-3002472.

PRICING OF STOCK EXCHANGE TRADING – THE ROLE OF NETWORK EXTERNALITIES

1 Introduction

Traditionally, the academic literature has regarded stock exchanges as regulated institutions with monopolistic features. This outlook for the stock exchange industry is arguably changing. Most importantly, European stock exchanges have increasingly turned into profit maximizing firms.

Characteristic for the European stock exchange industry is its three-layered structure as exchanges, brokers and investors are involved in the market. In this respect, the set-up resembles general vertical integration models (See e.g. Tirole, 1988, Hart and Tirole, 1999, Bonnano and Vickers, 1988 and Rey and Tirole, 1986). In vertical integration models the set-up consists of an upstream manufacturer, a downstream retailer and consumer demand. Moreover, there is a natural externality involved as manufacturing and retailing can be considered complement products. What consumers actually purchase is the combination of a producer's product and a retailers' service to deliver the product. Typically, these models examine contract design, risk considerations and the industry structure.

Basically, the stock exchange industry is similar; a stock exchange produces a trading service that is delivered to the investors by brokers. However, there is a typical feature of the stock markets that distinguishes them from previous vertical models. It is the existence of network effects such as liquidity¹. Brokers collect and compile orders gathered from investors and execute them in a stock exchange. Generally, European investors do not have direct access to stock exchanges and they are obliged to use

¹ A market place becomes more liquid as the number of traders increase and facilitate faster execution.

brokers for trading in listed shares. After all, investors generate trading activity in each stock exchange. Naturally, investors appreciate higher liquidity (see e.g. Economides and Siow, 1988). It is worth noting that only trading services are considered. Stock exchanges may also provide listing services for firms and some exchanges provide clearing and settlement services as well. Di Noia (1999) provides an analysis of network externalities when both trading and listing services are included. In contrast to the analysis of Di Noia, this paper focuses on trading services only. Generally, the model presented differs from a typical vertical integration model framework by including an investor-level network externality into the analysis.

The model will be based on the framework common in the telecommunications industry literature (e.g. Laffont et al. 1998a, 1998b) and first applied to the stock exchange industry by Shy and Tarkka (2001). In their paper, the stock exchange industry consisted of investors, two brokers, and two exchanges. Brokers and exchanges were assumed to locate in different countries and the investor market was assumed to be uncovered. This set-up allowed the examination of interconnection between exchanges. The set-up has been developed further by e.g. Tapking and Yang (2004) as they examine both trading and settlement services. I modify the set-up by assuming a monopoly exchange and brokers that are located in different countries. This modification simplifies the model, but allows other aspects, such as network externalities among investors, to be taken into account. The fact that exchanges have found it attractive to merge instead of relying on interconnection agreements justifies my approach². Recent examples of such mergers are the formation of EURONEXT and the creation of OMHEX. The EURONEXT is a merger between the exchanges of Paris,

² Mergers increase monopolistic features of exchanges, at the regional level, at least. Hence, I use the assumption of co-existence of the monopoly exchange and local brokers.

Amsterdam, Brussels, Lisbon and LIFFE in 2000 (Lisbon and LIFFE joined 2002). OMHEX is a result of the merger between OM, a technology company that operates Stockholmbörsen in Sweden and HEX, the Helsinki stock exchange, in 2003.

When it comes to the vertical structure of the stock exchange industry, I will examine three separate alternatives. First, the case of the monopoly exchange is studied. The second case covers co-operation between brokers and the monopoly exchange. In the third case, the vertically integrated industry structure is analyzed.

As mentioned above, network externalities play a key role in the stock exchange industry. I consider an investor-level network externality. Investors gain from more active markets as spread-related costs decrease due to increase in liquidity (i.e. the number of active investors). Technically, the network externality representing liquidity is based on Mason's (2000) article on Internet pricing. Furthermore, Gehrig (1998) has presented a spatial model of competing market places that has some level of resemblance to this article. His model examines a case of competing market places, which consist of a trading place and firms facilitating trading in those trading places. His set-up corresponds to the case where traders first choose the trading place and then the broker to execute trading. As for the monopoly exchange, it is assumed to have a positive effect arising from the economies of scale in its operation. So, there is only an indirect link between the exchange and network externalities. This is interesting, as it is widely stated that liquidity is of high priority for exchanges. If the exchange is a monopoly, does it really need to take account of the network externalities involved?

The article aims to apply the spatial set-up for the stock exchange industry. The three-layered spatial model is found appropriate for the following reasons. The model's structure corresponds to the vertical structure of stock exchanges and brokers in

Europe. Furthermore, it can be argued that the industrial structure analyzed is becoming more common wherever electronic order book systems are implemented. Secondly, the model presented allows study of the effects of network externalities. Thirdly, it can be argued that interaction between brokers is mainly driven by prices and differentiation. These elements are characteristic for spatial models. Nowadays, production of trading services is rarely capacity-constrained because of increasingly electronic exchanges.

It is worth noting that actual and potential competition has increased between stock exchanges in Europe. Increased competition is mainly due to deregulation, internationalization and technological development (see for instance, Di Noia 1999, ECB 2001). Therefore, it can be argued that applications to study the current industrial structure would at least require set-ups of oligopoly competition. Admittedly, this is out of the scope in this article. Taking account of competition between exchanges is an important task for future research. On the other hand, even though competition is intensifying, price schedules among stock exchanges are still heterogeneous. Typically, pricing components include a fee for admission to trade, an annual fee for membership, a fixed fee for trading, a variable fee for trading and discounts. In addition, there are numerous other fees related to trading services such as IT charges (see Andersen 2003). Also, an examination of multidimensional pricing in the case of stock exchanges is an issue for further research.

The model is presented in Section 2. The determination of fees in a case of investor level network externality is studied in Section 3. Conclusions are drawn in Section 4.

2 The model

This section introduces the market structure and presents the main elements of the model.

2.1 The industry set-up

The industry set-up has three layers. The stock exchange provides trading services for investors. Brokers distribute these services to final customers. The existence of brokers ensures anonymity of investors and allows sharing of the business risks³ involved in the execution of trades. Moreover, brokers often take care of related services such as settlement, clearing, and custody of stocks on behalf of investors. These services are excluded from the analysis. The third layer consists of the final customers, who are investors. They generate demand for trading services in the first place.

Numerous investors trade with each other through brokers. A trade consists of an order and its execution. First, the investor gives an order for a trade to a broker, who submits it to the exchange. The trade is created when the order is executed. The brokers involved and the exchange charge trading fees based on the customers' executed trades. Each trade has a buy-side and a sell-side service that involves the exchange and one or two brokers. Investors are assumed to gain utility from the externality effect. The more investors there are, the higher is the utility gained from the trading in a more liquid market (see Economides 1993⁴). This is due to the fact that in a more liquid market, the spread-related costs involved in trading diminish and the time for executing trades shortens. In the model, both of these features can be assumed to be included in the utility function of investors.

The two brokers provide matching services for their customers. Brokers aim to differentiate matching services by creating distance to the other broker. In this article

³ This kind of a business risk is a possibility of counterparty's failure.

⁴ In fact, Economides proposes two kinds of externalities: liquidity enhancements by size expansion and underpriced provision of market price information to outside rivals.

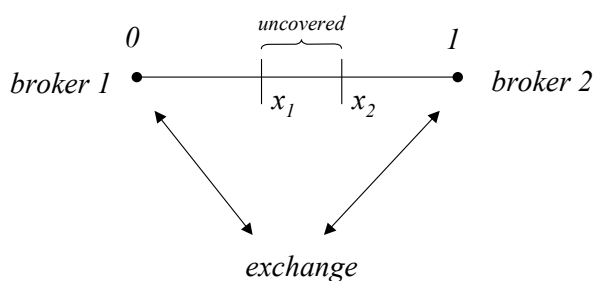
these transportation costs are referred to as communication costs. Brokers are assumed to operate in a linear city of investors as in Hotelling's (1929) market set-up. Brokers always charge linear transaction fees per trade from investors.

The monopoly exchange provides matching services for brokers. Like brokers the exchange is assumed to charge brokers linear transaction-based fees.

2.2 Investors

It is assumed that active investors have unit demands, i.e. they purchase one unit of trading services. Investors are located on a line equal to 1 in length. The market is assumed to be uncovered, i.e. there are inactive investors in the middle of the linear market. Inactive investors do not trade. On the other hand, investors' locations on the line reflect the differentiation between brokers. In the model, brokers 1 and 2 are assumed to locate in different countries⁵. The set-up is described in Figure 1.

Figure 1. **The linear market of brokers and investors**



Compared to with the paper of Shy and Tarkka (2001), the main difference is the assumption of the monopoly exchange. They assumed that trading was arbitrarily divided between two exchanges.

⁵ This assumption reflects the case of the OMHEX merger. After the merger, local brokers in Sweden and Finland execute their trades in the same exchange, even though they operate in geographically separate markets.

Let p and g denote trading fees per executed trade charged by brokers. V denotes the value of the sale/purchase service for the investor, t denotes the parameter for communication costs, and εD denotes the externality effect. Investors' utility can be written as⁶

$$(1) \quad U_{x_i, D} = \begin{cases} V - p - tx_1 + \varepsilon D & \text{if } i=1 \\ V - g - t(1-x_2) + \varepsilon D & \text{if } i=2 \end{cases}$$

Where x_1 denotes a distance to broker 1 where investors become indifferent between trading through broker 1 and being inactive. Respectively, $(1-x_2)$ denotes a location where investors become indifferent between trading through broker 2 and being inactive. Investors located between these two locations do not trade.

The network externality consists of the total demand for trading in the exchange, D , and, $\varepsilon (> 0)$, that is a fixed positive parameter describing the strength of the network externality. The total demand of the exchange consists of the sum of brokers' demands, $x_1 + (1-x_2)$. Hence, the network externality can be written as $\varepsilon D = \varepsilon(x_1 + (1-x_2))$. This reflects the idea that investors gain as the number of other investors increase independently of the choice of executing broker⁷.

Resolving for x_1 and $(1-x_2)$, yields the individual brokers' demands:

$$(2) \quad x_1 = \frac{V - p + \varepsilon(1-x_2)}{t - \varepsilon}$$

⁶ When network externalities exist, investors must form expectations regarding the size of the network. Katz and Shapiro (1985) use a notion of a fulfilled expectations equilibrium where at market equilibrium these expectations are always fulfilled. This assumption is used in the model.

⁷ This differs from e.g. Mason (2000). In his article the network externality is assumed to be dependent of total demand served by each producer individually.

$$(3) \quad (1 - x_2) = \frac{V - g + \varepsilon x_1}{t - \varepsilon}$$

In order to ensure positive demands it is assumed that $t > \varepsilon$. This means that communication costs must always exceed the utility gained from the strength of the network externality.

In the case of a partially covered market, brokers can be interpreted to be local monopolies serving different investor groups. In fact, passive investors who do not trade increase the market power of brokers. However, the network externality connects brokers' demands and hence pricing decisions, too.

2.3 Brokers and the exchange

Brokers role is to act as collectors of orders and execute trades in the exchange. Profits of the brokers can be written as⁸:

$$(4) \quad \pi_i = \begin{cases} x_1(p - f) & i = 1 \\ (1 - x_2)(g - f) & i = 2 \end{cases}$$

Where f denotes the transaction fee charged by the exchange.

The stock exchange executes order submitted by brokers. Thus, demand faced by the monopoly stock exchange is the sum of brokers' demands:

$$(5) \quad D = \frac{2V - p - g}{t - 2\varepsilon}.$$

Profit of the exchange can be written as:

⁸ It is worth noting that $D = (x_1 + (1 - x_2))$. The notation is chosen to better illustrate the intuition of the profit function.

$$(6) \quad \pi_e = D(f - c_e).$$

Next, equilibrium fees will be determined under investors' network externality as well as under different competitive set-ups.

3 Fees under investors' network externality

Optimal fees of brokers and the exchange will be resolved under investors' externality effect. Brokers' network externality and the exchange's economies of scale effect are left out from the analysis.

The timing of the game is the following:

Stage I: *Stock exchange sets its fee.*

Stage II: *Brokers set their fees.*

Stage III: *Investors determine whether to trade.*

The set-up will be resolved by using backward induction.

The behavior of investors in the case of partially covered market has been considered above. The equations (2) and (3) characterizes investor outcomes of Stage III.

In Stage II, brokers set fees for investors and maximize profits:

$$(7) \quad \max_p \pi_1 = \left[\frac{V - p + \varepsilon(1 - x_2)}{t - \varepsilon} \right] (p - f)$$

This results in the following reaction function for Broker 1:

$$(8) \quad p = \frac{1}{2} \frac{Vt + (t - \varepsilon)f - \varepsilon g}{t - \varepsilon}$$

Due to the symmetry of the optimization problem the reaction function of the Broker 2 can be written as:

$$(9) \quad g = \frac{1}{2} \frac{Vt + (t - \varepsilon)f - \varepsilon p}{t - \varepsilon}$$

It can be seen that fees of brokers are strategic substitutes as an increase in the rival's fee induces a decrease in the other's fee. In the uncovered market, the interaction between brokers arises from the existence of investor level network externality as well as from the fact that trades are executed in the same exchange (see also Shy and Tarkka, 2001). By lowering prices the other broker aims to increase the number of investors to replace the loss in total number of investors due to the rival's price increase⁹.

After substituting fees into each other, the exchange's demand (eq. (5)) can be presented as:

$$(10) \quad D = \frac{2(t - \varepsilon)(V - f)}{(2t - \varepsilon)(t - 2\varepsilon)}$$

$$\text{Where } \frac{\partial D}{\partial V} > 0, \quad \frac{\partial D}{\partial \varepsilon} > 0, \quad \frac{\partial D}{\partial t} < 0, \quad \text{and} \quad \frac{\partial D}{\partial f} < 0$$

The demand behaves intuitively; an increase in the investors' valuation of trading services and in the network externality have a positive impact on demand whereas an increase in the exchange's fee or communication costs decreases the demand.

In Stage I, exchanges set a transaction-based fee in order to maximize their own profit, given brokers' behavior.

⁹ See Section 4, for further discussion.

$$(11) \quad \max_f \pi_e = \left[\frac{2(V(t - \varepsilon) + f(\varepsilon - t))}{(2t - \varepsilon)(t - 2\varepsilon)} \right] (f - c_e)$$

Resolving for optimal fee for the exchange yields:

$$(12) \quad f = \frac{1}{2}(V + c_e)$$

The optimal fee is based on the value of trading service and the exchange's cost per trade. Thus, the monopoly exchange does not take into account the impact of the investor level externality effect when pricing its services. The independency of the network externality is somewhat counter-intuitive. One would expect that an increase in the externality would also lead to a positive impact on the exchange's fees. However, all the trades will be executed in the exchange despite the level of its fees. On the other hand, exchange's fees partly determine market coverage, which also takes account of the externality's impact.

Now, by substituting (12) into (10), (9) and (8), the total demand and the brokers' fees in the equilibrium can be written as:

$$(13) \quad D = \frac{(t - \varepsilon)(V - c_e)}{(2t - \varepsilon)(t - 2\varepsilon)}$$

$$(14) \quad p = g = \frac{1}{2} \left(\frac{(3V + c_e)t - (V - c_e)\varepsilon}{2t - \varepsilon} \right)$$

To ensure positive demand, it is assumed that the communication cost is twice as large as the externality effect, $t > 2\varepsilon$ and that the value of trading services of investors exceeds the cost per trade of the exchange, $V > c_e$.

The profits of brokers and the exchange can be written as:

$$(15) \quad \pi_b = \frac{1}{4} \left(\frac{(t-\varepsilon)(V-c_e)^2 t}{(2t-\varepsilon)^2 (t-2\varepsilon)} \right) \quad \text{and}$$

$$\pi_e = \frac{1}{2} \left(\frac{(t-\varepsilon)(V-c_e)^2}{(2t-\varepsilon)(t-2\varepsilon)} \right)$$

Equilibrium solutions for demand, fees and profits allow an analysis of the impact of the investor-level network externality.

Proposition 1: When brokers and the exchange do not co-operate under investor-level network externality, the following holds:

$$\frac{\partial D}{\partial \varepsilon} = \frac{(3t^2 - 4t\varepsilon + 2\varepsilon^2)(V - c_e)}{(2t - \varepsilon)^2 (t - 2\varepsilon)^2} > 0, \quad \frac{\partial p}{\partial \varepsilon} = \frac{\partial g}{\partial \varepsilon} = \frac{(V - c_e)t}{(2t - \varepsilon)^2} > 0,$$

$$\frac{\partial \pi_b}{\partial \varepsilon} = \frac{(V - c_e)t}{4} \frac{(4t^2 - 7t\varepsilon + 4\varepsilon^2)(V - c_e)}{(2t - \varepsilon)^2 (t - 2\varepsilon)^2} > 0, \quad \frac{\partial \pi_e}{\partial \varepsilon} = \frac{(V - c_e)}{2} \frac{(3t^2 - 4t\varepsilon + 2\varepsilon^2)(V - c_e)}{(2t - \varepsilon)^2 (t - 2\varepsilon)^2} > 0$$

On the basis of the proposition 1, it can be argued that an increase in the positive network externality of investors leads to an increase in total demand, brokers' fees and profits of all market institutions. In the case of fees and profits, the positive impact follows from the fact that entry of new market participants is not included in the model. Naturally, higher profits would otherwise induce entry. As far as the pricing of the stock exchange is concerned, higher demand increases profits, even though the exchange's fee is independent of the network externality. If the externality increases it leads to an increase in demand and consequently in profits, but the exchange's fees remain unchanged.

Next, two cases of co-operation are examined. In the first case the brokers are assumed to maximize their joint profit and in the second case the joint profit of the brokers and the exchange is analyzed.

3.1 Brokers' collusion

The model above assumes that brokers are local monopolies that are located in different countries. However, brokers have also increased their international activities recently. It can be argued that brokers have actually led internationalization in stock markets. In the present framework, international consolidation can be examined by assuming collusion between the local monopolies. Under this kind of co-operation the brokers maximize their joint profit:

$$(16) \quad \max_{p,g} \pi_1 + \pi_2 = \left(\frac{Vt - pt + (p - g)\varepsilon}{t(t - 2\varepsilon)} \right) (p - f) + \left(\frac{Vt - gt + (g - p)\varepsilon}{t(t - 2\varepsilon)} \right) (g - f)$$

Now, prices are jointly determined and do not reflect interaction between the brokers. The optimization yields the following pricing functions that can be compared to the case competition between brokers (see Section 3.3 for comparisons):

$$(17) \quad p = \frac{-2\varepsilon g + tf + Vt}{t - \varepsilon} \quad \text{and} \quad g = \frac{-2\varepsilon p + tf + Vt}{t - \varepsilon}$$

Now, the exchange's demand can be written as

$$(18) \quad D = \frac{V - f}{(t - 2\varepsilon)}$$

The exchange solves its fee by maximizing profits, which yields similar fees as before:

$$(19) \quad f = \frac{1}{2}(V + c_e)$$

In the case of no collusion the brokers are two local monopolies that are connected by the network externality. As they collude they act as one monopoly. However, their position with respect to the exchange has not changed. All the trades will be executed in

the exchange despite the structure of the broker industry. Therefore, pricing of the exchange remains unchanged.

Now, the total demand and brokers' fees in the equilibrium can be written as:

$$(20) \quad D = \frac{1}{2} \frac{V - c_e}{(t - 2\varepsilon)}$$

$$(21) \quad p = g = \frac{3}{4}V + \frac{1}{4}c_e$$

The profits of brokers and the exchange can be written as:

$$(22) \quad \begin{aligned} \pi_b &= \frac{1}{16} \left(\frac{(V - c_e)^2}{(t - 2\varepsilon)} \right) \quad \text{and} \\ \pi_e &= \frac{1}{4} \left(\frac{(V - c_e)^2}{(t - 2\varepsilon)} \right) \end{aligned}$$

It can be argued that it is in the brokers' interest to decrease communication costs in order to increase the impact of the positive externality on their profits under co-operation. This is a different finding compared to spatial models without collusion. Generally, spatial models provide arguments for creating differentiation (i.e. communication costs) in order to increase profits.

Again, what is the impact of the investor-level network externality? And how does it compare to the case of no co-operation between brokers?

Proposition 2: When brokers co-operate with each other under investor-level network externality, the following holds:

$$\frac{\partial D}{\partial \varepsilon} = \frac{(V - c_e)}{2(t - 2\varepsilon)^2} > 0, \quad \frac{\partial p}{\partial \varepsilon} = \frac{\partial g}{\partial \varepsilon} = 0,$$

$$\frac{\partial \pi_b}{\partial \varepsilon} = \frac{(V - c_e)^2}{8(t - 2\varepsilon)^2} > 0, \quad \frac{\partial \pi_e}{\partial \varepsilon} = \frac{(V - c_e)^2}{2(t - 2\varepsilon)^2} > 0$$

By interpreting proposition 2, it can be argued that an increase in the positive network externality of investors leads to increases in total demand and profits as well. However, due to the co-operation, the network externality does not have any impact on brokers' fees.

Is the impact of the investors' network externality larger or smaller compared with the case of no collusion (proposition 1)? In the case of fees the outcome is evident, as the externality has no impact. As for demand and profits, the outcome becomes subject to the following conditions. In the case of demand, the impact is smaller compared with the case of no co-operation if $\varepsilon > \sqrt{2} + t$. The effect of the network externality on the brokers' profits is smaller under co-operation if $\varepsilon < 2t$. Similarly, the impact on the exchange's profits is smaller under co-operation compared to the case of no co-operation if $V > 5c_e$.

As the conditions show it is not straightforward how the impact of the investor-level network externality changes as the co-operation between market institutions increases. Hence it cannot be straightforwardly argued that a collusive market structure would enable brokers to take full advantage of appreciation of liquidity among investors. How the market structure interacts with the network effect eventually depends on the level of the network effect.

3.2 Joint profit maximization

Traditionally, broker-members have owned stock exchanges. Alternatively, stock exchanges may have operated as co-operatives. These set-ups are examined in Di Noia (1999) and Nocke et al. (2004). Di Noia studies exchanges as co-operatives and Nocke et. al take the trading-platform approach. In particular, Nocke et. al examine alternative ownership structures of a platform which could be interpreted as a stock exchange where companies list their stocks that are purchased by investors. In that sense their approach differs from the present set-up, where the focus is on the provision of trading services to investors.

Let us assume that the exchange and the brokers maximize joint profit ($\pi_1 + \pi_2 + \pi_e$).

$$(23) \quad \max_{p,g} \pi_1 + \pi_2 + \pi_e = x_1 p + (1 - x_2)g - (x_1 + (1 - x_2))(c_e)$$

Optimization yields the following pricing functions:

$$(24) \quad p = \frac{1 - 2\varepsilon g + tc_e + Vt}{2(t - \varepsilon)} \quad \text{and} \quad g = \frac{1 - 2\varepsilon p + tc_e + Vt}{2(t - \varepsilon)}$$

Now, the total demand and brokers' fees in the equilibrium can be written as:

$$(25) \quad D = \frac{V - c_e}{(t - 2\varepsilon)}$$

$$(26) \quad p = g = \frac{1}{2}(V + c_e)$$

The profits of brokers (it is assumed that ownership is equally shared between brokers) and the exchange can be written as:

$$(27) \quad \begin{aligned} \pi_b + \frac{1}{2}\pi_e &= \frac{1}{4} \frac{(c_e - V)^2}{(t - 2\varepsilon)} \quad \text{and} \\ \pi_e &= \frac{(c_e - V)c_e}{(t - 2\varepsilon)} < 0 \end{aligned}$$

It is worth noting that the exchange makes a loss. In general, brokers can maintain the exchange by letting the exchange charge fees that allow it to break even or by injecting capital to cover losses.

When all market institutions co-operate, the network externality has the following impact on demand, fees and profits.

Proposition 3: When brokers own the exchange and co-operate with each other under investor-level network externality, the following holds:

$$\begin{aligned} \frac{\partial D}{\partial \varepsilon} &= \frac{2(V - c_e)}{(t - 2\varepsilon)^2} > 0, \quad \frac{\partial p}{\partial \varepsilon} = \frac{\partial g}{\partial \varepsilon} = 0, \\ \frac{\partial \left(\pi_b + \frac{1}{2}\pi_e \right)}{\partial \varepsilon} &= \frac{(-V + c_e)^2}{2(t - 2\varepsilon)^2} > 0 \end{aligned}$$

Also in this case, it can be argued that an increase in the positive externality effect leads to increases in total demand, prices and the brokers' profits as well. It is worth noting that the brokers' profits consist of their own profit and the share of the exchange's profit.

A comparison with the case of brokers' co-operation shows that the impact of the externality is smaller on demand if $t > 2\varepsilon$ and on brokers' profits if $\varepsilon < 2t$ and $V \neq c_e$. Hence, it can be argued that when communication costs exceed the level of the externality, market institutions can increase the impact of the externality on demand by increasing co-operation. However, large communication costs set limits for favorable

impact on profits. It should be noted that impacts on the exchange's profits are not worth considering separately as they are included in the brokers' profits.

3.3 The impact of vertical integration under investor externality

This section analyses the results derived above by comparing the equilibrium profits of exchanges and brokers with respect to vertical industry structures.

Basically, comparisons are based on the assumption that the value of trading for investors exceeds the cost per trade of the exchange, $V > c_e$. The exchange charges the same fee under different competitive conditions. However, this is not the case in joint profit maximization (the case of the vertically integrated industry).

The exchange's equilibrium demands under different levels of co-operation between market institutions can be ranked in the following way:

$$(28) \quad D(\text{no collusion}) < D(\text{brokers' collusion}) < D(\text{joint profit max})$$

The brokers' equilibrium fees under investor-level externality effect are ranked as follows:

$$(29) \quad p(\text{joint profit max}) < p(\text{brokers' collusion}) < p(\text{no collusion})$$

And the brokers' equilibrium profits are ranked as:

$$(30) \quad \pi_b(\text{no collusion}) < \pi_b(\text{brokers' collusion}) < \pi_b + \frac{1}{2}\pi_e(\text{joint profit max})$$

The case of profit ranking under the broker-level externality effect is subject to an assumption, $V > c_e$. This assumption states that co-operation is profitable whenever the investors' valuation of trading service exceeds the exchange's cost per trade.

On the basis of the comparison, it can be argued that, conditionally, the joint profit maximization results in the lowest prices and the highest demands as well as the highest profits for brokers. This finding matches a proposition of Shy and Tarkka (2001). They argue that in an uncovered market, trading services are strategic substitutes due to the fact that an increase in the fee of broker 1 has negative impact on market participation. In order to smooth the impact, broker 2 decreases its fee. This creates a fruitful basis for co-operation among market institutions. The co-operation increases the market size and the brokers' and exchange's profits.

This finding, however, raises several questions. What if the cost for the exchange exceeds the value of trading for investors? The condition suggests that in such a case, no trading service is provided. Hence, when trading services are provided, the co-operation between brokers and the exchange is the dominant market structure in the light of demand, fees and profits. So are current institutional structures of stock markets artificial and in fact limiting the size of the markets? Should co-operation counter to competition regulations be allowed in the case of stock markets? Moreover, it can be added that there are also other factors to be taken into account. Such factors are liquidity and economies of scale in producing the exchanges' trading services. In fact, these factors are likely to strengthen the finding. On the other hand, the finding is due to the assumption of an uncovered market, which means the existence of passive investors. Therefore, it is worth noting that giving definitive answers to the questions presented above is beyond the scope of this study.

4 Conclusions

The article builds on the assumption that stock exchanges are turning into profit-maximizing firms. Hence, the principles and methods common in the industrial organization literature are applied. It can be argued that the assumption at least holds for European stock exchanges. Moreover, it can be expected that the increasing usage of electronic trading systems will lead to similar industrial configuration in other parts of the world as well. The model focused on trading services only. Other services typical for exchanges were not included in the model.

The article presented a three-layered spatial model with a positive network effects on investor-level. While assuming linear transaction-based fees for both brokers and the monopoly exchange, three different competitive set-ups were studied. The structures analyzed were no collusion, collusion between brokers, and joint profit maximization.

It was found that the monopoly exchange does not take into account the impact of the investor-level externality effect when pricing its services. The independence of the network externality is somewhat counter-intuitive. One would expect that an increase in the externality would lead to a positive impact on the exchange's fees and make investors more willing to pay for liquidity. However, all the trades will be executed in the exchange despite the level of its fees. On the other hand, the exchange's fees partly determine market coverage, which also takes account of the externality's impact.

It turned out that joint profit maximization results in the lowest prices and the highest demand as well as the highest profits for brokers under the investors' externality effect.

References

- Amihud, Jakov and Mendelson, Haim (1986): Asset Pricing and the Bid-Ask Spread, *Journal of Financial Economics* Vol 17, 1986.
- Andersen Atso (2003): Competition Between European Stock Exchanges, HSE Working Paper W-343, 2003.
- Bonnano, Giacomo and Vickers, John (1988): Vertical Separation, *The Journal of Industrial Organization*, Vol. 36, No. 3, pp. 257-265.
- Bresnahan, Timothy F. and Salop, Steven C. (1986): Quantifying the Competitive Effects of Production Joint Ventures, *International Journal of Industrial Organization*, Vol. 4, pp. 153-175.
- Di Noia, Carmine (1999): The Stock-Exchange Industry: Network Effects, Implicit Mergers, and Corporate Governance, *Quaderni di Finanza*, March 1999.
- Economides, Nicholas and Siow, Aloysius (1988): The Division of Markets Is Limited by the Extent of Liquidity (Spatial Competition with Externalities), *American Economic Review*, Vol 78, no.1, pp. 108-121.
- European Central Bank (2001): European Equity Markets, ECB Euro Equity Markets Report, August 2001.
- Fudenberg, Drew and Tirole, Jean (1984): The Fat-Cat Effect, The Puppy-Dog Ploy, and the Lean and Hungry Look, *American Economic Review* May 1984, Vol. 74, pp. 361-66.
- Gehrig, Thomas (1998): Competing Markets, *European Economic Review*, 42 (1998), pp. 277-310.
- Hart, Oliver and Tirole, Jean (1999): Vertical Integration and Market Foreclosure, *Brookings Papers on Economic Activity, Microeconomics*, vol. 1990, pp. 205-286.
- Hotelling, Harold (1929): Stability in Competition, *Economic Journal*, Vol 39, No. 153, pp. 41-57.
- Katz, Michael and Shapiro, Carl (1985): Network Externalities, Competition, and Compatibility, *American Economic Review*, Vol. 73, No. 3, pp. 424-440.
- Laffont, Jean-Jaques, Rey, Patrick and Tirole, Jean (1998a): Network Competition: I. Overview and Nondiscriminatory Pricing, *RAND Journal of Economics*, Vol 29. No. 1 Spring 1998, pp. 1-37.
- Laffont, Jean-Jaques, Rey, Patrick and Tirole, Jean (1998b): Network Competition: II. Price Discrimination, *RAND Journal of Economics*, Vol. 29. No. 1 Spring 1998, pp. 38-56.
- Mason, Robin(2000): Simple Competitive Internet Pricing, *European Economic Review*, Vol. 44(4-6), 2000, pp. 1045-1056.
- Mitchell, Bridger M. and Vogelsang, Ingo (1991): *Telecommunications Pricing: Theory and Practice*, Cambridge University Press 1991.

- Nocke, Volker, Peitz Martin and Stahl, Konrad (2004): Platform Ownership, Penn Institute for Economic Research Working Paper 04-029.
- Oren, Shmuel S. Smith, Stephen A. and Wilson, Robert B. (1983): Competitive Nonlinear Tariffs, *Journal of Economic Theory*, Vol. 29, pp.49-71.
- Rey, Patric and Tirole, Jean (1986): The Logic of Vertical Restraints, *The American Economic Review*, Vol 76, No. 5, pp. 921-939.
- Reynolds, Robert J. and Snapp, Bruce R. (1986): The Competitive Effects of Partial Equity Interests and Joint Ventures, *International Journal of Industrial Organization*, Vol 4, pp. 141-153.
- Salop, Steven C. (1979): Monopolistic Competition with Outside Goods, *Bell Journal of Economics*, Vol. 10, No.1 pp. 141-156.
- Shy, Oz and Tarkka, Juha (2001): Stock Exchange Alliances, Access Fees and Competition, *Bank of Finland Discussion Papers 22/2001*.
- Tapking, Jens and Jing Yang (2004): Horizontal and Vertical Integration in Securities Trading and Settlement, *European Central Bank Working Papers No. 387*, August 2004.
- Tirole, Jean (1988): *The Theory of Industrial Organization*, MIT Press 1988.
- Wilson, Robert B. (1993): *Nonlinear Pricing*, Oxford University Press 1993.

**ESSAY III: Assessing Demand for and Pricing of Stock Exchange
Trading Services**

(Unpublished)

ASSESSING DEMAND FOR AND PRICING OF STOCK EXCHANGE TRADING SERVICES*

Atso Andersén**

21.2.2005

Abstract

The objective of this article is to assess demand for share trading services. A price schedule is simulated for the Helsinki stock exchange. The results of the study indicate that demand for trading services is elastic. It is argued that appropriate quantity discounts could be profitable for the Helsinki stock exchange.

Keywords: Stock exchanges, demand, trading services, nonlinear pricing

JEL classification: D42; L12; L22; G29

* The author wishes to thank Pekka Ilmakunnas, Otto Toivanen, Ville Aalto-Setälä and Karlo Kauko for their comments. All errors are those of the author. The author has received financial support from the Alfred Kordelin Foundation, The Finnish Foundation for Advancement of Securities Markets, The Finnish Foundation for Economic and Technology Sciences – KAUTE, HSE Foundation. and the Research Foundation of Co-operative Banks.

** Ph.D. student, Helsinki School of Economics, Department of Economics, P.O. Box 1210, 00101 Helsinki, Finland, e-mail: atso.andersen@hkkk.fi, tel. +358-50-3002472.

ASSESSING DEMAND FOR AND PRICING OF STOCK EXCHANGE TRADING SERVICES

1 Introduction

In the empirical industrial organization literature, stock exchanges are examined only to a limited extent despite their central role in the financial market infrastructure. Hence, the literature is growing rapidly (see e.g. Schmiedel 2004 for a review). However, demand for and pricing of secondary market trading services of shares has so far not been considered. Instead, numerous articles study the total costs of share trading from the investors' perspective without mentioning the extensive literature on market microstructure (see e.g. Stoll 2001). As distinct from the earlier empirical literature on trading costs, this paper studies demand for trading services from the exchange's perspective.

Studies examining trading costs are generally based on specific market structures (see e.g. Mildestein and Schleef, 1983 and Economides and Heisler, 1994). Moreover, the roles of liquidity and timing of the execution have proved important from the investors' perspective (Economides and Schwartz, 1995). As far as the market microstructure literature is concerned, spread analysis generally plays the key role, even though the full costs of trading would include taxes and other fees levied on trades. To some extent, spread analysis includes potential for qualitatively examining the nature of demand from the exchange perspective. For instance, an article by de Jong et al. (1995) allows comparison of trading costs between the exchanges of Paris and London. In their article, trading costs are measured as effective and quoted bid-ask spreads¹. Nevertheless, their results indicate that trading costs are lower in Paris compared with

¹A (quoted) spread is the difference between buy and sell offers. An effective spread is the difference between quotes and actual transaction prices.

London despite the fact that trading activity is higher in London. This indicates that measuring investors' total trading costs without mentioning its impact on investors' decision-making may be a highly complex task. A further example of spread analysis is provided by e.g. the article of Barclay et al. (1998) where exchanges in the United States are compared. Again, bid-ask spread analysis indicates that higher transaction costs in the form of larger bid-ask spreads reduce trading volume among stocks that are transferred between NYSE, AMEX and Nasdaq. Thus, it can be argued that to some extent studies on market microstructure seem to characterize both the nature of demand and also price competition between exchanges. However, the interpretation is often limited to spreads only, and is different from the pricing analysis common in industrial organization literature.

In the literature on total trading costs, the costs are generally divided into explicit costs like fees and commissions and implicit costs such as market impact costs² (see Berkowitz et al. 1988 and Domowitz et al. 2000, Domowitz 2001). Characteristically, in Domowitz et al. (2000) the relationships between trading cost, liquidity and volatility are studied across countries and over time. They find evidence that investors' demand for trading services is price sensitive. From the exchange perspective, this suggests that provision of trading services does not differ from providing any other service and it should be considered according to the same economic principles. In fact, Domowitz and Steil (1999) argue that the trading industry could be successfully analyzed in the framework of industrial economics. This argument acts as a guideline for the assessment of demand for and pricing of trading services presented in this article.

² Implicit cost is calculated as the difference between the actual trade price and the benchmark price of the trade day.

A brief study of the price schedules of European stock exchanges reveals that pricing of share trading services has components generally found in the non-linear pricing literature. The basic idea of nonlinear pricing is to connect prices to the quantities of customers' purchases in order to capture unsatisfied demand. Nonlinear pricing can be successfully applied when³ 1) the producer has monopoly power, 2) resale markets are limited, 3) the producer can monitor purchases and 4) there are no regulatory barriers to nonlinear pricing. Share trading services fulfill these feasibility conditions. Usually, the exchange has at least some regional pricing power. There are no resale markets for trading services executed in the exchange. The exchanges are able to observe members' behavior and disaggregated demand data is available. In regulation, quantity discounts (second-degree of price discrimination) are generally allowed in the case of intermediated demand. Therefore, examination of non-linear pricing in the case of stock exchanges is justified.

The objective of this study is to model demand for trading services in the case of the Helsinki stock exchange and to determine the optimal non-linear price schedule on the basis of demand analysis. A monopoly producer set-up will be applied.

The tools and concepts for the supply side analysis of non-linear pricing can be found in the economics of industrial organization and more particularly from the extensive literature on telecommunications pricing and competition. Nonlinear pricing in particular has been extensively studied in the economics literature (e.g. Tirole 1988, Brown and Sibley 1986 and Wilson 1993). Generally, nonlinear pricing is about second-degree price discrimination, which is the case with quantity discounts. When second-degree price discrimination is applied, prices do not differ according to

³ See Wilson (1993).

consumers, but according to the quantity purchased. So far, the literature on nonlinear pricing has concentrated on monopoly settings (Mitchell and Vogelsang 1991). However, there exists an increasing literature on nonlinear pricing in competitive situations that is potentially applicable to the stock exchange industry (see e.g. Oren, Smith and Wilson 1983, Valletti 1998 and Min et al. 2002, Laffont, Rey and Tirole 1997, 1998a, 1998b, Stole 2003, Armstrong and Vickers 2001 and Yin 2004).

When it comes to empirical work on nonlinear pricing, the studies concerning telecommunication have focused on monopoly situations where services are provided directly to final customers (see e.g. Bousquet and Ivaldi 1997 and Aldebert, Ivaldi and Roucolle 2004). Recently, studies on nonlinear pricing in the case of oligopolistic competition have emerged (McManus 2002 and Miravete and Röller 2003). However, these models use extensive data on rival producers and final customers in determining demand. In the case of stock trading services such information is rarely available. In order to describe demand behavior at a level that still allows analysis, a method of demand profiles provides a potential framework for the study (Wilson 1993). The method is based on measuring demand profiles. The demand profiles identify the number of customers (brokers, in this case) purchasing predefined quantities. This is different from a traditional analysis, which is based on purchased quantities.

Section 2 briefly characterizes operative landscape of Helsinki stock exchange. Section 3 presents a framework for assessing trading services. Section 4 presents data and variables for estimations. Section 5 reports the estimation results for demand. Section 6 assesses the pricing structure of the Helsinki stock exchange. Section 7 provides an informal analysis of the structure of broker demands. Section 8 concludes.

2 The operative landscape of the Helsinki Stock Exchange

The Helsinki exchange was established in 1912. The Helsinki Stock Exchange, previously operating as an informal association catering for business needs, became a co-operative society in 1984. The co-operative Helsinki Stock Exchange was a non-profit organisation, promoting its members' business by maintaining an unbiased marketplace for securities trading with ancillary services. In connection with the organisational change, associations that promoted the operations of public companies and securities markets were admitted as members of the Co-operative, in addition to banks and other stockbrokers. In 1987-1989, the Co-operative Helsinki Stock Exchange carried out a reform and the electrical quotation board was replaced with an electronic trading system. Securities trading as a whole adopted a new HETI system (Helsinki Stock Exchange Automated Trading and Information System) on 1 April 1990. During the 1990s, several measures were taken to rationalize market structures and to streamline operations:

- In the autumn of 1995, The Co-operative Helsinki Stock Exchange became a joint stock company.
- In early 1997, The Central Share Register of Finland, the Helsinki Stock Exchange settlement operations, the Helsinki Money Market Centre and the Association of Book-entry Securities were merged to form the Finnish Central Securities Depository (APK).
- In December of 1997, the cash and derivatives marketplaces, the Helsinki Stock Exchange Ltd and SOM Ltd, merged to become HEX Ltd, the Helsinki Stock and Derivatives Exchange, Settlement Company, i.e. the Helsinki Exchanges.
- The spring 1998, the Helsinki Exchanges bought the entire share capital of the Helsinki Book-entry Securities Centre Ltd and agreed with the Finnish Option Exchange Ltd on transferring its derivatives operations to the Helsinki Exchanges.

- In November of 1998, the Helsinki Exchanges announced a strategic plan for establishing the globally competitive Marketplace Helsinki, which is based on an independent national marketplace and international co-operation. As part of this strategy implementation, the Helsinki Exchanges and the Central Securities Depository merged into the new HEX Group (Helsinki Exchanges Group Plc).

From 2000 to 2003, internationalisation of the institutional structure of the marketplace took place as follows:

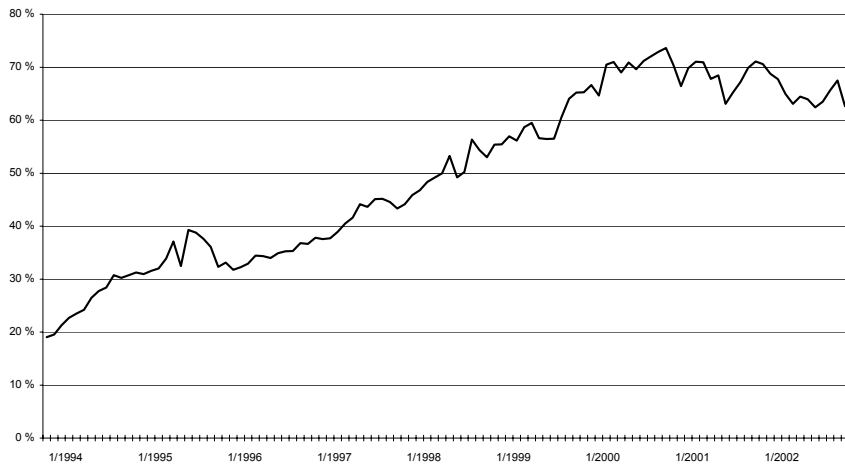
- In 2001 HEX acquired a majority stake in the Tallinn Stock Exchange.
- In summer 2002 HEX acquired a majority stake in the Riga Stock exchange.
- In spring 2003, a merger between OM, the parent company of Stockholmbörsen, and HEX was implemented.

The trend of internationalization has been predominant in the activity of markets as well. As the Figure 1 shows, the level of foreign ownership of Helsinki stock exchange market capitalization has increased steadily during the 1990s and has remained stable in recent years.

Moreover, an increase in the number of remote brokers provides further evidence of internationalization. The number of remote brokers has increased from two in 1997 to 28 in 2003. At the same time, the number of local brokers has declined from 21 in 1997 to 16 in 2003. Despite the downward trend of recent years in market capitalization, the level of activity has increased in the long run.

Figure 1.

The level of foreign ownership of market capitalization



Suorce: HEX

For instance, the market capitalization of the Helsinki stock exchange has increased from 73.3 billion USD in 1997 to 138.8 billion USD in 2002. The value of turnover has also risen from 36.2 billion USD in 1997 to 178.2 billion USD at the end of 2002.

2.1 Other indications of the competitive landscape of Helsinki stock exchange

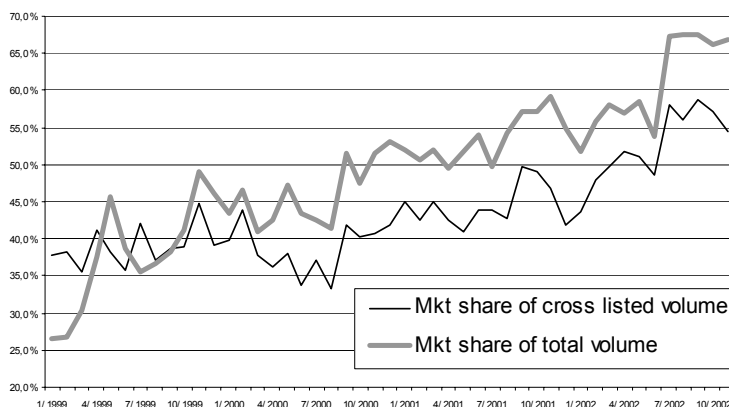
According to the results in Andersen (2003a), European stock exchanges operate in monopolistic competition. However, differences between the competitive landscapes of exchanges were found. In the case of the Helsinki stock exchange, no underlying structure of competition could be identified.

The level of cross-listings and the market share of Helsinki may provide some indication of the level of competition. Currently, there are 15 companies listed in Helsinki that also have cross-listed shares in other stock exchanges. The most important of these companies is Nokia, which accounts for the majority of turnover both in Helsinki and among the cross-listed shares. Stock exchanges that have cross-listed

shares with Helsinki are (Stockholm), Copenhagen, London, Germany (XETRA, Frankfurt and other OTC markets), Paris, Amsterdam, NYSE, and Nasdaq.

The level of market share of Helsinki stock exchange's potential volume turnover is presented in Figure 2 below. The market share is measured by dividing the number of shares traded on the Helsinki stock exchange by the sum of turnovers of shares listed in Helsinki stock exchange worldwide⁴. Market share figures are presented separately for both total activity and for cross-listed shares. It can be seen that the market share has arisen to approximately 55 percent of cross-listed shares and to 65 percent of total volume by the end of the 2002. The increase in market share can be largely explained by the centralization of Nokia-denominated trading to Helsinki.

Figure 2. **The market share of Helsinki stock exchange of its potential volume turnover (incl. Nokia)**



Source: Datastream and HEX

⁴ That is, by adding together turnover in Helsinki and the turnovers of cross-listed shares in other exchanges.

Initially, fragmented market shares among the European stock exchanges may have been due to factors like time zones and other transaction costs based on distance between listed companies and investors as well as on institutional differences. However, it can be argued that these costs are declining continuously because of technological development and internationalization. On the basis of these arguments, one would have expected concentration of trading volumes on a European level in a couple of financial centers. Nevertheless, this has not been the case with the Helsinki stock exchange. On the contrary, recent development seems to have allowed remote exchanges like Helsinki to increase foreign ownership and their market shares.

In this paper, however, it is assumed that the Helsinki exchange operates as a local monopoly.

2.2 Current price schedules of stock exchange trading services

In Europe, stock exchanges generally have price schedules that include non-linear elements. Typically, pricing components consist of a fee for admission, an annual fee for membership, a fixed fee for trading, a variable fee for trading, and discounts. In addition, there are numerous other fees related to trading services such as IT charges. A brief characterization of price schedules in European exchanges is presented in Table 1.

In addition, stock exchanges may use separate price schedules for different lists as well as for different trading phases. Therefore, it can be argued that some elements of capacity pricing are also present.

Table 1.

Price schedules in European stock exchanges, 2002

	Copenhagen	Euronext	Germany (XETRA)	Helsinki	London	Oslo	Switzerland	Vienna
Fixed fee for admission	-	-	-	X	-	-	X	-
Fee for membership	-	-	-	X	X	X	X	X
Other fees	X	X	-	-	X	-	-	X
Fee based on number of trades	Uniform	Nonlinear	Nonlinear	Nonlinear	Uniform	Uniform	Nonlinear	-
Fee based on value of trades	Uniform	-	Nonlinear	Uniform	Nonlinear	Nonlinear	Nonlinear	Nonlinear
Discounts	X	-	X	-	-	-	X	-

x states for the existence of the pricing component.

Evidently, pricing practices in European stock exchanges are heterogeneous. Some of the pricing schedules are so multidimensional that brokers are not likely to be able to optimize trading patterns.

The price schedule of the Helsinki stock exchange is no exception. It has elements of nonlinear pricing. In fact, there are two different price lists with mainly similar structures but different price levels. The basic structure of a price schedule contains:

- Fixed annual membership fee
- Fixed monthly fee per member
- Varying basic fee paid by each party per executed order for under/over 10 000 trades per month
- Variable fee paid by each party based on the value of trade depending on the stage of trading (i.e. different fee for automated and negotiated trades in continuous trading, prelist opening and block trading)
- Minimum monthly fee for share trading

Currently, the price of trading services depends upon both volume and value of executed trades. Furthermore, the schedule also has elements of capacity pricing as trading phases are priced differently. In 1999, the fees were based only on the value of

trades. The price schedule has become more complex over time as can be seen in Table 2. The price level in the schedules increased until April 2002, when a price reduction was implemented. See Appendix 2 for detailed information.

Table 2. **Structural development of Helsinki stock exchange price schedule 1998-2002**

	1998	1999	2000	2001	2002
Fixed monthly fee	X	X	X	X	X
Fixed fee shared among members	X	X	-	-	-
Basic fee per executed order	-	-	Nonlinear	Nonlinear	Nonlinear
Alternative price lists	-	-	2	2	2
Fee on the value of executed orders	X	X	X	X	X
Share specific fee on the value	X	X	-	-	-
Elements of capacity pricing	X	X	X	X	X
Minimum monthly fee	-	-	X	X	X

x states for the existence of the pricing component.

When compared with other European stock exchanges, the price schedule of the Helsinki stock exchange is among the most multidimensional ones. From the perspective of brokers, this may create a competitive disadvantage for trading in Helsinki.

Next, the theoretical framework of demand for and supply of trading services will be presented. The framework allows an examination of demand and simulation of optimal pricing for the Helsinki stock exchange.

3 The framework for assessing trading services

Demand for trading services will be analyzed in the framework proposed by Wilson (1993). It is assumed that brokers act on behalf of investors and that brokers are able to fully regroup orders so that the order flow, i.e. the demand for trading services, to exchanges is determined by brokers.

3.1 The model of demand

Traditionally, the demand properties of the services are determined by examination of the utility functions of customers. This holds for empirical studies of demand under non-linear pricing as well (see e.g. Mitchell and Vogelsang 1991, Bousquet and Ivaldi 1997 and Aldebert et al. 2004). Typically, these studies are based on two-stage budgeting problem of consumers. The consumers first choose how much income to allocate on the service examined. In the second stage, consumers choose how much of the service to use. Alternatively, discrete-choice models can be applied for evaluating non-linear pricing in monopoly or competitive set-ups. However, these models are based on the idea that consumers either choose to purchase or not. Basically, price discrimination arises from product differentiation, which has an impact on consumers' willingness to purchase (see e.g. McManus 2002 and Miravete and Röller 2003).

However, the consumer demand approach is difficult to apply to trading services due to the industry's vertical structure. Trading services produced by exchanges are sold to brokers that represent final customers. Brokers also trade on their own behalf. These characteristics create substantial heterogeneity among the exchange's customers. The heterogeneity cannot be captured by applying a traditional utility function approach. Secondly, the data that would allow a determination of demand for stock exchanges' trading services in this manner was not available. The utility function-based analysis would require detailed data on investors as well as on brokers.

Another common approach to empirically analyze market demand is to use data on prices, quantities sold and market characteristics, such as structural factors of the market, product characteristics and so forth. Typically, these models are based on the assumption that there is a unique market price for the product in question. Also, two-

part pricing, which is the most common form of non-linear pricing, could be applied in this framework. In the case of the exchange this approach would mean separate examination of a fixed fee and a fee per trade. However, the two-part tariff approach would result in a linearly decreasing price schedule. In order to increase non-linearity, additional pricing components and data on them would be required. This kind of data is not available, either.

To overcome these problems in creating a non-linear price schedule, Wilson (1993) proposes a method to study demand behavior in circumstances where no information to construct traditional demand curves is available. He argues that by using demand profiles it is possible to characterize demand and calculate optimal nonlinear price schedules. Wilson uses two definitions for the demand profile function $N(p)$:

- For price p the demand profile specifies the number of customers, $N(p)$, purchasing at least q units
- The demand profile specifies for each q -th unit the number $N(p)$ of customers that are willing to pay the price p for that unit.

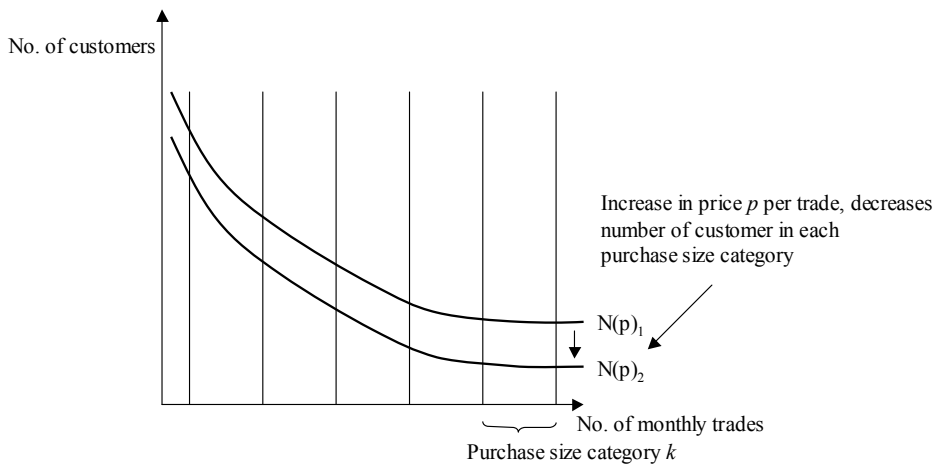
Instead of a traditional examination of the demand relationship between price and quantity, the relationship between the number of customers buying a certain monthly purchase size k and the average price p per trade⁵, is studied. When the price is increased, it is expected that the number of customers in predetermined purchase size categories decrease. In fact, each purchase size category can be interpreted to represent a market of its own. This assumption is an important difference from traditional empirical market level demand models, which are based on the assumption of a single market price. Examination of independent category specific markets allows for

⁵ In practise, pricing is based on the number of executed orders, which are here referred to as trades.

simulation of an optimal price for each of them. See Figure 3 for characterization of purchase size categories and the impact of a price increase.

In theoretical terms each purchase size category is infinitesimally small. However, in empirical applications purchase size categories must be defined appropriately. In this paper it is assumed that the size of each purchase category is a 1000 trades. In other words, the market is divided into subsequent segments of 1000 trades.

Figure 3. **Purchase size categories and the impact of an increase in price**



The demand profile summarizes the heterogeneity among brokers at the level of aggregation that still allows analysis of nonlinear pricing. By using the disaggregated data on trading activities of the brokers, it is possible to construct demand profiles for each type of exchange's members.

Basic assumptions that allow the usage of the demand profiles in the case of a single service with a single quantity dimension are the following⁶:

- The demand profile is nonnegative and decreasing in the quantity variable q .
- The demand profile approaches zero as price or purchase size increases to infinity. In other words, potential demand is bounded.
- The demand profile is twice differentiable.
- The profit function (of an exchange) is quasi-concave and has a single local maximum.
- The price schedule cuts the conventional demand curve once from below.

The third assumption presupposes the continuity of the demand profile function. A caveat related to this is that as the number of customers diminishes, the usage of demand profile becomes less admissible. The fourth assumption must hold for each purchase size category. The fifth assumption ensures that there is a unique optimal quantity for each customer type. However, the fifth assumption excludes price schedules such as two-part tariffs that cut the demand function also at zero quantity⁷.

It is assumed that the number of customers i.e. demand profile function in each purchase category depends only on the price of trading services. The demand profile function can be written in the following way:

$$(1) \quad n_k(p) = \beta p$$

where n_k denotes the number of customers and p denotes the price of the exchange and β denotes the level of price impact on the number of customers. It is worth noting that the price is assumed to be equal for all the categories. Moreover, it is assumed that the

⁶ The assumptions are based on Wilson (1993).

⁷ For further details see Wilson (1993) and Mitchell and Vogelsang (1991).

exchange is a monopoly in producing trading services. This demand profile function will be used as a basis for demand estimations.

Both the demand profile and the method to calculate quantity-based elasticity can be applied on the level of an individual exchange⁸. The demand profiles n_k of the individual exchange can be written as:

$$(2) \quad q(p) = \sum_k n_k(p) \rho_k$$

where q denotes the quantity of trades, p denotes the price of the exchange, n_k denotes the number of customers and ρ_k denotes the size of a purchase size increment. It is worth noting that in this paper the price per trade p is not a purchase size specific variable. In the case of uniform pricing, the price per trade is equal for all the categories. However, the price could also be category specific. Especially, in the case of non-linear pricing the price could be different for each category, as category-specific markets are assumed to be independent. Moreover, the price per trade is assumed to be constant within a category.

Intuitively, the total quantity purchased in each purchase size category is a product of the number of customers and the size of the category (i.e. an increment in the purchase size). The total quantity demanded can be determined by summing over purchase size categories. For instance, if the size of categories were a thousand trades, the amount purchased in a specific category would be the number of customer in that category times the thousand trades.

Respectively, the elasticity faced by the exchange i can be written as⁹:

⁸ See Mitchell and Vogelsang (1991).

$$\begin{aligned}
\varepsilon_{q_i(p_i)} &= \frac{\partial q_i(p_i)}{\partial p_i} \frac{p_i}{q_i(p_i)} = \\
(3) \quad \sum_k \frac{\partial n_k(p_i) \rho_k}{\partial p_i} \frac{p_i}{q_i(p_i)} &= \sum_k \varepsilon_n \frac{n_k(p_i) \rho_k}{q_i(p_i)} = \sum_k \varepsilon_n \frac{n_k(p_i) \rho_k}{\sum_k n_k(p_i) \rho_k} \\
&= \sum_k \varepsilon_n w_k
\end{aligned}$$

The traditional price elasticity of demand can be interpreted to be a weighted average of demand profile elasticities. The weights consist of the quantity of trades in the involved category divided by the total quantity of all trades.

3.2 The econometric specification of demand

In order to study demand behavior empirically, purchasing each increment will be considered as a separate and independent segment of the total market faced by the Helsinki stock exchange. Specifications for segment specific estimation models will be presented next.

The econometric analysis requires a specific functional form for the demand profile. It is assumed that demand profile functions take a log-linear functional form.

$$(4) \quad \log n_{k,t} = a_k - \beta_k \log p_t + d_k \text{trend}_t + u_{t,k}$$

In the specification, p_t denotes the price of Helsinki stock exchange and trend_t denotes a trend variable. The specification is interpreted so that the direct effect of the price, β_k , is negative onto the number of brokers in segment k .

The supply and demand system determining the price of trading services includes an endogeneity problem. The endogeneity arises from the fact that in addition to demand also exchange's marginal costs and other supply shifters simultaneously determine the

⁹ It should be noted that it is assumed that exchanges have equal pricing structures.

price level. However, in the case of exchanges this relationship should not be emphasized too much even though brokers are assumed to be able to regroup orders. For investors, the price of trading services has a minor role when the decision of trading is made in the first place. Trading is mainly initiated by other factors such as valuation levels and liquidity needs, for instance. In order to examine whether there is endogeneity involved both two-stage and ordinary least squares model estimations will be presented.

Alternative approach could be to use Poisson type models as the demand profiles are integer functions. However, taking account of endogeneity and other technical issues involved in Poisson-type models is left for future examination.

It is worth noting that the number of brokers has increased over the period of study. The distribution of trades has simultaneously spread, indicating a decreasing degree of concentration of trading services among brokers. Similarly, the value of turnover has increased over time, thus spreading to a larger number of brokers. To control the impact of the increase in the number of brokers and other potential factors excluded from the analysis, a time trend variable is included.

4 Data and variables for estimations

The data set used for estimation covers monthly observations for the period 1/1999 to 6/2002. The data set consists of 42 months and 35 purchase size categories and the total number of observations is 1470. See Table 3 for descriptive statistics.

It is worth noting that fees are assumed to be equal for each purchase size category. Basically, this derives from the fact that exchange's price schedule is partly based on the value of turnover, which is beyond the scope of this paper. Instead, it is assumed

that the size of each trade is the average trade size. Next, the detailed illustration of the simplification procedure is presented.

Table 3. **Descriptive statistics for the purchase size category variables**

	No. of brokers in profile	Total no. of brokers	Fees
Mean	11.64966	31.11905	2.532458
Median	10.00000	28.00000	2.668487
Maximum	45.00000	45.00000	2.899479
Minimum	1.000000	24.00000	1.939206
Std. Dev.	8.239463	6.163429	0.389418
Skewness	0.968965	0.832429	-0.718230
Kurtosis	3.786599	2.504036	1.809108
Observations	1470	1470	42
Purchase size categories	35	35	-
Months	42	42	42

Most importantly, in the case of the price schedule of Helsinki stock exchange, the effects of membership fee and the elements of capacity pricing are ignored. From the brokers' perspective, the membership fee represents a relatively small part of the total access costs (inc. other fees, personnel costs, hardware etc.) Elements of capacity pricing are ignored as the majority of trading takes place during continuous trading. As far as the minimum monthly fee is concerned, it is assumed that each broker has a level of activity, that results in fees over the defined monthly minimum. Finally, the value dimension is in practice excluded from the analysis as the value-based fee per trade is determined by the market average trade size. Hence, the actual price schedule of Helsinki stock exchange is approximated into a one-dimension format. Moreover, it is also assumed that all brokers have rationally chosen the price list that is economically efficient at a market average trade size. In sum, the point of departure for estimation is a

single average price per trade¹⁰. This information is used to estimate price elasticities in each demand profile. On the basis of the resulting set of elasticities, the optimal non-linear price schedule based on trading volumes can be simulated.

The data to form demand profiles includes all executed trades in all shares listed in Helsinki Exchange during the sample period. In order to construct a profile matrix for brokers' demand, data on the number of executed trades per broker is used. The trading statistics is disaggregated by purchase size categories so that the first category includes the number of all the brokers that have executed the specified minimum number of trades or more whereas the last and the largest purchase category includes only the largest brokers. The structure of the demand profile matrix is described in Table 4 below.

Table 4. **The structure of the demand profile matrix**

Category	1	2	...	K
Period $t=1$	$n_{1,1}$	$n_{1,2} = n_{1,1} - n(q_{b,1,1} < q_{b,1,2})$...	$n_{1,k-1} = n_{1,k-1} - n(q_{b,1,k-1} < q_{b,1,k})$
Period $t=2$	$n_{2,1}$	$n_{2,2} = n_{2,1} - n(q_{b,2,1} < q_{b,2,2})$...	$n_{2,k-1} = n_{2,k-1} - n(q_{b,2,k-1} < q_{b,2,k})$
...
Period $t=m$	$n_{m,1}$	$n_{m,2} = n_{m,1} - n(q_{b,m,1} < q_{b,m,2})$...	$n_{m,k-1} = n_{m,k-1} - n(q_{b,m,k-1} < q_{b,m,k})$

Where $n_{1,1}$ denotes the number of brokers in period 1 in category 1, $n(q_{b,1,1} < q_{b,1,2})$ denotes the number of brokers in period 1, whose amount of purchased services, q , entitle them to participate in the category 1 but not in the category 2.

As it is illustrated in Table 5, the demand profiles are found to be in line with the basic assumptions made in Section 3.1. Moreover, the numbers of brokers in purchase size categories can be represented in a common form of time-series. Each purchase size category establishes individual time-series describing broker activity in the specified market segment over time.

¹⁰ Alternatively, price approximations could have been based on the value dimension of the pricing schedule. The nature of data restricts the analysis of multidimensional pricing as the number of customers turns out to be too low in each value/volume-category.

Table 5. Sample of the demand profile matrix

Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35		
Period 1 (no of customers)	33	31	31	30	27	26	25	23	21	18	18	17	17	16	16	16	16	15	14	13	13	11	11	10	10	10	10	9	9	8	8	8	7	6	6		
Period 2 (no of customers)	37	34	33	30	29	26	24	22	21	21	20	19	16	15	14	14	14	14	14	14	13	12	11	11	11	11	11	10	8	8	8	7	6	6	6		
Period 3 (no of customers)	34	33	30	27	23	21	18	16	15	15	14	13	12	9	9	8	8	8	6	6	5	5	5	5	3	3	3	3	3	2	1	1	1	1	1		
Period 4 (no of customers)	37	35	35	33	31	27	24	22	21	19	18	18	18	18	17	17	17	15	14	13	11	9	9	9	9	9	9	7	7	6	5	5	5	5	4	4	
Period 5 (no of customers)	38	36	35	33	26	25	22	22	20	18	18	18	18	16	15	15	13	10	9	9	9	8	7	7	6	5	4	3	3	3	3	3	3	3	3	3	3
Period 6 (no of customers)	44	43	38	35	27	26	23	23	21	20	19	19	17	15	15	15	12	11	11	11	11	8	8	7	7	5	4	3	3	3	3	3	3	3	3	3	3
Period 7 (no of customers)	40	40	38	33	28	26	24	24	24	23	22	21	20	18	16	16	14	13	10	10	10	10	9	9	9	8	7	5	4	3	3	2	2	2	2	2	2
Period 8 (no of customers)	42	41	39	35	29	27	24	21	20	19	18	17	16	14	14	14	12	10	10	10	10	9	9	6	4	4	4	3	3	3	3	3	2	2	2	2	2

5 Estimation procedure and results

Only the demand side of the framework presented for assessing trading services will be examined. Particularly, coefficients for each purchase size category will be estimated separately with the logarithmic specification presented in equation (4). The estimations for each category are conducted with the 2SLS (two-stages least squares) method. The reason for applying the 2SLS method arises from the endogeneity involved in the price and the number of brokers in the framework presented. When the data is scarce the instrumentation is also challenging. Optimally, instrumentation would be based on variables that are correlated with prices, but not correlated with the error term. Such a variable could be monthly marginal costs. However, such variables are not present. Technical solutions, such as using lagged price variables, are not possible either due to autocorrelation (see further details below). Hence, the best available solution for instrumentation will be applied.

The instrumentation in 2SLS estimations will be based on logarithms of personnel and other expenses of the Helsinki stock exchange, constant and trend-variable. Expenses are assumed exogenous to the number of brokers whilst correlated with the price. Original data on expenses is on yearly level. Monthly level instrument series are reconstructed by dividing annual data on expenses equally over months. The manner of disaggregation is based on an assumption that the majority of expenses in the exchange accrue evenly over time rather than over the level of activity.

In the first stage of estimation the endogenous regressor, p_t is regressed on a constant and the instrumental variables to obtain a fitted value for the price variable. In the second stage, the dependent variable, $n_{k,t}$ is regressed on a constant and the fitted value of the price variable.

As far as autocorrelation is concerned, Breusch-Godfrey serial correlation LM tests indicate the existence of first-order autocorrelation. Also, low levels on Durbin-Watson statistics (values approx. 1.5) indicate the existence of positive autocorrelation. The existence of autocorrelation may be due to variables omitted from the estimation that are correlated across periods. To control autocorrelation, AR(1) specification is applied in the models for each purchase size category. Hence, the error term can be written as $u_{t,k} = \tau_{t,k}u_{t-1} + \varepsilon_{t,k}$, where $\tau_{t,k}$ denotes the first-order serial correlation coefficient. A time trend variable is included to control potentially omitted variables. The effect of heteroscedasticity is corrected by using White heteroskedasticity-consistent standard errors.

Estimations were also conducted by using OLS (ordinary least squares) method as well as SUR (seemingly unrelated regression) method since demand profiles form a recursive model. Brokers' participation in the smaller categories is a precondition for participation in the larger ones. In the SUR estimation, a system of equations with identical regressors is used.

5.1 Results

In general, the estimated price coefficients of 2SLS models indicate that demand is inelastic in the small categories. Demand seems to become more elastic as the total purchase size increases. This result is in line with the general assumptions of the demand profiles. The level of the statistical significance varies over categories. In the case of the price coefficient, statistical significance is found satisfactory in the middle categories. All the estimated coefficients in the 2SLS models are reported in Table 7. Appendices 3 and 4 report estimation results for OLS models and for the SUR system.

The values of AR(1) coefficients are relatively high and generally statistically significant, hence suggesting the presence of autocorrelation. When it comes to the trend coefficients, their values are generally low and statistically significant only in the smallest categories. In the majority of categories, the trend variable is not found statistically significant.

In three categories results are inconsistent with the theoretical framework (positive coefficient values). However, all these coefficients are not statistically significant. The inconsistency may arise from several sources. The trend variable and the instruments have not captured all the endogeneity or the impact of unobservable factors. Hence, prices and trading activity move in the same direction in those categories. Potentially, the exchange has correctly anticipated the increase in volume and increased prices at the same time. Alternatively, the number of customers in those three categories has increased simultaneously with the exchange's price increases due to structural or administrative decisions among brokers active in those categories. In such a case, instruments have not cleaned the endogeneity problem adequately. The instruments were found to be significantly correlated with the prices and not with the error terms, even in the three categories with wrong-signed coefficient values.

Estimations were also conducted with both the OLS (ordinary least squares) method and the SUR (seemingly unrelated regression) method since demand profiles form a recursive model. Brokers' participation in the smaller categories is a precondition for participation in the larger ones. In the SUR estimation, a system of equations with identical regressors was used.

Table 6.

Direction of the bias: Estimation results for the 9th purchase size category

Dependent Variable: Number of brokers ($\log(n_{i,k})$)			
Method: Two-Stage Least Squares			
Independent Variables in category 9	2SLS	OLS	SUR §
<i>Constant (a)</i>	1.937	2.192	2.326
	<i>0.236</i> ***	<i>0.194</i> ***	<i>0.125</i> ***
<i>Helsinki (β_i)</i>	-0.725	-0.354	-0.165
	<i>0.315</i> **	<i>0.266</i>	<i>0.162</i>
<i>Trend (d)</i>	0.008	0.012	0.014
	<i>0.005</i> *	<i>0.004</i> ***	<i>0.003</i> ***
<i>AR(1)</i>	0.389	0.392	0.344
	<i>0.165</i> **	<i>0.154</i> **	<i>0.037</i> ***
R^2	0.751	0.764	0.759

Standard errors are reported in italics.

***,**, * indicate significance at the 1,5,10 percent levels respectively.

§ corresponding equation from the system of SUR-equations.

OLS estimations can be used to examine the direction of the endogeneity bias. The bias can be briefly characterized by comparing the 2SLS and OLS estimates of e.g. the 9th purchase size category in Table 6.

It can be seen that in the case of the Helsinki-price coefficient (β_i), the bias is towards zero as the OLS estimate value -0.354 compared to 2SLS estimate value -0.725 shows. It can also be argued that there exists some level of correlation between the disturbance terms of equations in different categories since the OLS and the SUR estimates differ in value. It is also worth noting that the statistical significance of the price coefficients also varies in the OLS and SUR estimations.

Table 7. Estimation results for demand profiles

Dependent Variable: Number of brokers (n)																			
Method: Two-Stage Least-Squares																			
Independent Variables		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
in category k:																			
<i>Constant</i>		2.886	2.822	2.825	2.611	2.545	2.399	2.181	2.004	1.937	1.901	1.740	1.820	1.439	1.140	1.108	0.689	0.486	0.562
		0.110	0.142	0.109	0.117	0.134	0.175	0.186	0.188	0.236	0.292	0.331	0.403	0.305	0.408	0.562	0.491	0.546	0.571
		***	***	***	***	***	***	***	***	***	***	***	***	***	***	*			
<i>Helsinki (β_i)</i>		-0.074	-0.104	-0.037	-0.298	-0.317	-0.388	-0.587	-0.754	-0.725	-0.655	-0.844	-0.669	-1.082	-1.369	-1.352	-1.774	-1.910	-1.721
		0.109	0.120	0.152	0.161	0.192	0.249	0.267	0.261	0.315	0.393	0.433	0.565	0.415	0.555	0.802	0.709	0.720	0.746
			*		*		**	**	***	**	*	*	**	**	**	*	**	**	**
<i>Trend (d)</i>		0.018	0.018	0.018	0.014	0.012	0.011	0.009	0.007	0.008	0.010	0.007	0.009	0.006	0.004	0.003	0.001	0.001	0.002
		0.004	0.005	0.002	0.002	0.002	0.003	0.004	0.004	0.005	0.006	0.006	0.008	0.006	0.007	0.010	0.009	0.009	0.009
		***	***	***	***	***	***	***	***	*	*	*	*	*	*	*	*	*	*
<i>AR(1)</i>		0.734	0.779	0.516	0.427	0.148	0.374	0.364	0.329	0.389	0.465	0.463	0.456	0.362	0.374	0.461	0.350	0.309	0.372
		0.121	0.125	0.155	0.167	0.195	0.187	0.155	0.160	0.165	0.209	0.197	0.229	0.137	0.178	0.181	0.182	0.168	0.172
		***	***	***	**	*	*	**	**	**	**	**	*	**	**	**	*	*	**
		0.946	0.939	0.932	0.919	0.852	0.853	0.795	0.733	0.751	0.789	0.716	0.719	0.713	0.664	0.665	0.665	0.647	0.664
Independent Variables		19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
in category k:																			
<i>Constant</i>		0.369	0.041	-0.680	-0.889	-0.469	0.202	-0.787	1.434	1.553	1.643	0.925	0.727	-1.297	-2.725	-2.485	-2.534	-2.294	
		0.652	0.766	0.975	1.023	1.050	0.942	1.223	1.416	1.171	1.184	0.970	0.906	1.225	1.551	1.526	1.483	1.514	
															*	*	*	*	*
<i>Helsinki (β_i)</i>		-1.858	-2.169	-2.820	-3.010	-2.293	-1.356	-2.492	0.096	0.238	0.299	-0.432	-0.652	-3.026	-4.923	-4.616	-4.625	-4.254	
		0.853	0.923	1.135	1.162	1.202	0.929	1.483	0.965	0.856	0.847	0.809	0.766	1.604	2.100	2.050	1.969	2.025	
		**	**	**	**	*	*	*	*	*	*	*	*	*	**	**	**	**	**
<i>Trend (d)</i>		0.002	0.001	0.001	-0.001	0.008	0.014	0.005	0.010	0.009	0.006	0.003	0.001	-0.013	-0.032	-0.033	-0.033	-0.030	
		0.011	0.011	0.012	0.014	0.014	0.015	0.017	0.039	0.036	0.036	0.033	0.032	0.025	0.027	0.025	0.023	0.025	
<i>AR(1)</i>		0.378	0.390	0.324	0.443	0.472	0.608	0.496	0.817	0.826	0.829	0.801	0.812	0.640	0.426	0.408	0.340	0.389	
		0.199	0.168	0.170	0.209	0.204	0.157	0.198	0.122	0.113	0.101	0.096	0.091	0.161	0.237	0.234	0.253	0.243	
		*	**	*	**	**	***	**	***	***	***	***	***	***	*	*	*	*	*
		0.632	0.623	0.600	0.649	0.675	0.720	0.678	0.745	0.751	0.745	0.731	0.759	0.670	0.541	0.539	0.488	0.463	

Standard errors are reported in italics. ***, **, * indicate significance at the 1, 5, 10 percent levels respectively.

5.2 Robustness of results

The statistical significance of estimations changes over categories. Hence, the results should be interpreted cautiously. In order to strengthen the interpretation of the results, the robustness of the models was examined more closely by excluding the time trend. The impact of autocorrelation and its dynamics were not analyzed in more detail as Breusch-Godfrey serial correlation LM tests (and Durbin-Watson statistics) suggested the existence of first-order autocorrelation.

Table 8.

Robustness of results: Estimation results of the 9th purchase size category

Dependent Variable: Number of brokers ($\log(n_{i,k})$)		
Method: Two-Stage Least Squares		
Independent Variables in category 9 :	2SLS	Robustness
<i>Constant (a)</i>	1.937 <i>0.236</i> ***	1.626 <i>0.263</i> ***
<i>Helsinki (β_i)</i>	-0.725 <i>0.315</i> **	-1.247 <i>0.279</i> ***
<i>Trend (d)</i>	0.008 <i>0.005</i> *	- -
<i>AR(1)</i>	0.389011 <i>0.165237</i> **	0.496 <i>0.153</i> ***
<i>R²</i>	0.751	0.685

Standard errors are reported in italics.

***, **, * portray significance at the 1,5,10 percent levels respectively.

The robustness models result in price elasticity coefficients that are not more in line with the theoretical assumptions (five wrong-signed coefficients compared with three in full models). The coefficients also indicate more elastic demand in robustness models. Moreover, the price coefficients in the set of robustness models without the trend variable are statistically more significant. The omitted variable models do not, however,

have as a good fit as the full models do. Table 8 presents results of the robustness model compared with the full model coefficients in the 9th category.

The results of robustness models suggest a tendency towards more elastic demands as purchase categories increase. Hence, the robustness tests provide some level of confirmation for the full models -estimations as the findings are corresponding.

Estimated demand elasticities allow further analysis of the pricing structure. Next, estimation results are applied on supply side modelling to assess optimal pricing structure for the Helsinki stock exchange.

6 Assessing trading services pricing in the Helsinki Stock Exchange

In this section, a reconstruction of a nonlinear and a linear price schedules will be presented. The reconstruction will be based on demand estimations and considering arbitrary values for marginal costs of the Helsinki stock exchange. Hence, it is possible to qualitatively examine what is the level of marginal costs that would result a pricing scheme that corresponds to the current level of trading fees in the Helsinki stock exchange.

6.1 The model of supply of trading services

The behavior of the stock exchange is analyzed in the framework of monopoly market structure. It is assumed that the exchange is prepared to adjust the prices of trading services in each purchase size category. Brokers consider buying additional amount of trades in predetermined increments. For instance, after purchasing a certain number of trades the broker decides whether to buy the next predetermined increment of trades. Each of the increments in the trading volume establishes a profit contribution for the

exchange. Thus, each purchase size category is analyzed as an independent market segment.

The size of the profit contribution depends on the total number of brokers, n_k , the exchange has as customers in each purchase size category, the price-cost margin per trade in the category, $(p_k - c)$, and the size of the increment, ρ_k . The total profit contribution for the exchange is determined by summing over the purchase size categories:

$$(5) \quad \pi_k = \sum_k n_k [p_k - c] \rho_k$$

The exchange maximizes its profit by choosing the price per trade in each purchase size category optimally. Thus, the first order condition for profit-maximization for the exchange in segment k can be written as (see Appendix 1):

$$(6) \quad \frac{\partial \pi_k}{\partial p_k} = \left[n_k + (p_k - c) \frac{\partial n_k}{\partial p_k} \right] \rho_k = 0.$$

Due to the lack of appropriate marginal cost data, only the demand side of the market system was estimated. However, the supply side will be studied by applying arbitrary values for marginal costs. On the basis of this kind of simulation, the structure and level of current pricing in the Helsinki stock exchange can be assessed.

6.2 The structure of the reconstructed price schedule

To form a price schedule, the optimal prices are determined for each purchase size category. On the basis of optimal prices, a total price schedule can be expressed as a function of the volume of trading. The total price schedule is comparable to the existing price schedules.

The condition for optimal marginal price for exchange i can be written as follows (see Appendix 1):

$$(7) \quad p_{i,k} = \frac{c_i}{\left(1 - \frac{1}{\beta_{i,k}}\right)}$$

To construct the optimal price schedule for total purchased quantities, category specific prices¹ are first multiplied with quantity increments and summed up to the last purchase size category purchased (subscript i is dropped):

$$(8) \quad P_{opt,k} = \sum_{k=1}^k (p_k * \rho_k)$$

This is the total fee associated with the number of trades. To determine price per trade (total marginal price), the total fee will be divided by the total number of trades associated with the category:

$$(9) \quad \text{optimal fee} = P_{opt,k} / \text{trade} = \frac{\sum_{k=1}^K (p_k * \rho_k)}{\sum_1^k \rho_k}$$

In reconstructing the optimal price schedule, parameters for demand elasticity and marginal costs are needed. The values for demand elasticities of 2SLS estimations are applied. To overcome problems with coefficient values, right-signed coefficients, which have statistical significance of the level of at least 10 percent, are included. Moreover, some coefficients have values less than unity. This means that the marginal revenue on the level of total demand is negative and against the profit maximization condition.

¹ Results from equation (7).

Hence, only estimates over unity are included in the reconstruction. The closest appropriate elasticity estimate is applied if the original coefficient is excluded.

Since there is no fully reliable data available on marginal costs of the Helsinki stock exchange, arbitrary values must be used. The marginal production cost of trading service is assumed to be constant over the production scale. Four cases are considered. The value of the marginal costs is assumed to be fixed at the levels 0.2 €, 0.3 € and 0.4 € per trade in simulations based on category specific estimations. Moreover, marginal cost is assumed fixed at 1.0 € in the case based on aggregated price elasticity.

Figure 4. **Simulated marginal price schedules**

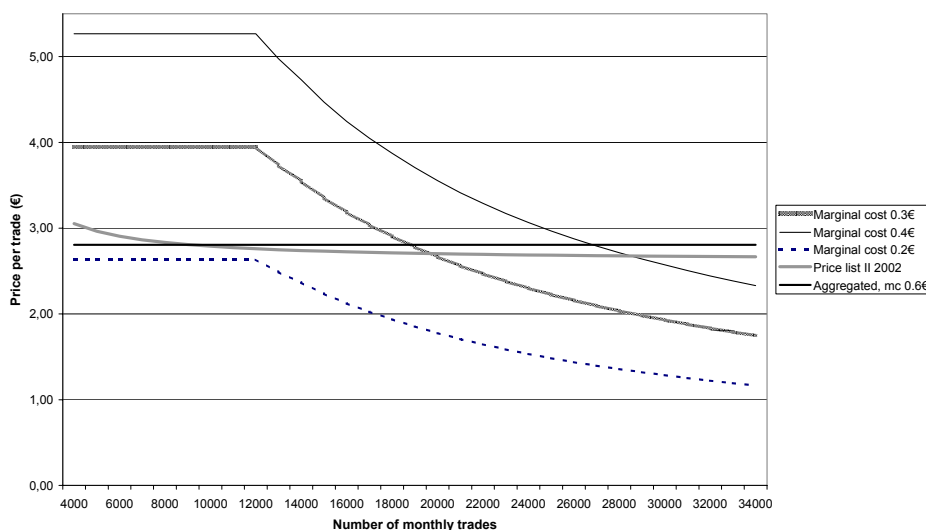


Figure 4 shows that simulated price schedules present a tendency towards higher prices for smaller purchases and lower prices for larger purchases. The result suggests that to enhance profitability and demand for trading services, the exchange should apply quantity premiums for the smallest brokers and quantity discounts for the largest brokers.

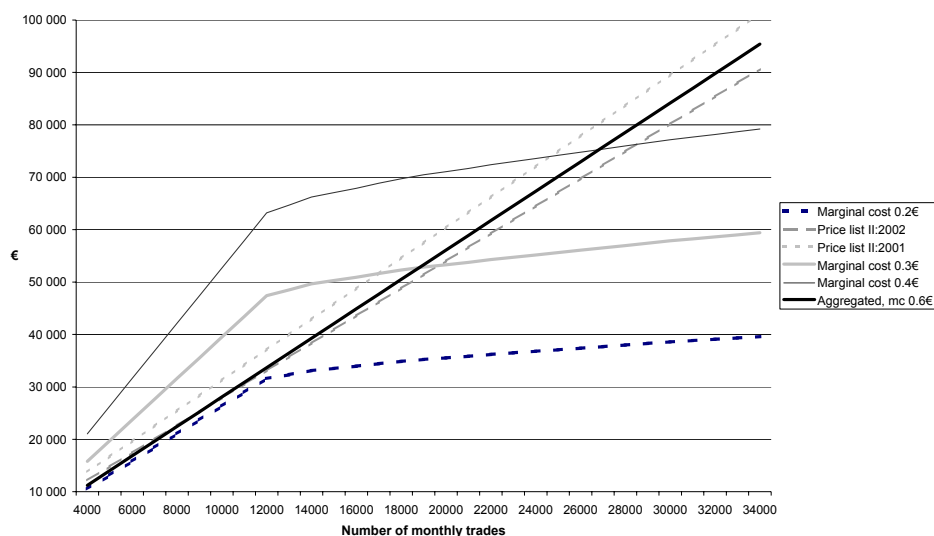
Category-specific demand elasticities allow determination of optimal linear price for trading services, as well. Appendix 1 shows that the linear price schedule can be based on the weighted average of the category-specific elasticities. This elasticity is found to be -1.272 . It is worth noting that this figure includes at least all the elasticity coefficients of statistical significance at the level of 10 percent.

The reconstructed price schedules can be compared with the current structure of pricing in Helsinki stock exchange. The simulation results indicate that the actual pricing of the trading services corresponds roughly to the case of nonlinear pricing and marginal cost of 0.6 € per trade. Nevertheless, the analysis should be considered tentative at most, since simulated schedules are based on hypothetical marginal cost values.

To give perspective to the applied marginal cost values, let us consider the available information about costs of the Helsinki stock exchange. Generally, costs of providing trading services consist mainly of personnel and system costs. In order create understanding of marginal costs of trading personnel and other costs are weighted by trading revenue share of total income and then divided per number of trades. If measured this way, the marginal costs in 1999 were 7.42 € per trade, in 2000 5.15 € per trade and 2001 9.08 € per trade. Compared to 0.6 € per trade these figures are high.

The price schedules for brokers' monthly purchases in Figure 5 below characterize cumulative fees as purchased quantities increase. It can be seen that an application of nonlinear pricing would also have an impact on the total fees charged by the exchange.

Figure 5. **Total fee associated with the number of trades**



In the presented framework, definitions of optimal prices for each purchase size category separately establish the fundamental basis for nonlinear pricing. In other words, the market faced by the Helsinki stock exchange was segmented and optimal prices were defined for each sub-segment. The defined optimal price schedule corresponds to the volume-based pricing of trading services. However, in practice, pricing of trading services is currently far more multidimensional. In order to develop the framework to match this complexity, the structure of the market analyzed as well as the price schedule could be taken into account in a more detailed manner. For instance, market activity could be divided into volume and value components. However, more sophisticated analysis would require increasingly advanced multi-dimensional computational methods. Moreover, as mentioned before, the limited number of customers creates problems in the more detailed examination.

Even though the determined nonlinear pricing structure would be optimal from the perspective of the exchange, its applicability depends on the structure of brokers' demands.

7 Conclusions

The objective of this article is to assess the demand for share trading services. Furthermore, the structure and the level of the pricing of share trading services in Helsinki stock exchange are examined.

The estimations indicate that the Helsinki stock exchange faces demand that becomes more elastic as the purchased amounts of its trading services increase. On aggregate level, the demand is found to be elastic.

Comparison of current fees per trade on the Helsinki stock exchange with simulated optimal price schedules indicates that quantity premiums for the smallest brokers and quantity discounts for the largest brokers could be applied.

The analysis of the fees of trading services in Helsinki stock exchanges also showed that the fee structure is multidimensional compared with its European rivals.

References

- Aldebert, Marc, Ivaldi, Marc and Roucolle, Chantal (2004): Telecommunications Demand and Pricing Structure: An Econometric Analysis, *Telecommunication Systems*, Vol. 25, No. 1, 2, pp. 89-115.
- Andersen, Atso (2003a): Competition between European stock exchanges, Helsinki School of Economics Working Paper W-342.
- Barclay, Michael J., Kandel, Eugene and Marx, Leslie M. (1998): The Effects of Transaction Costs on Stock Prices and Trading Volume, *Journal of Financial Intermediation*, Vol 7. pp. 130-150 (1998).
- Berkowitz, Stephen A., Logue, Dennis E. and Noser, Eugene A. Jr. (1988): The Total Cost of transactions on the NYSE, *Journal of Finance*, Vol. 43, Issue 1, 97-111, March 1988.
- Bousquet, Alain and Ivaldi, Marc (1997): Optimal Pricing of Telephone Usage: An Econometric Implementation, *Information Economics and Policy* 9 (1997) 219-239.
- Bresnahan, Timothy (1989): Empirical Studies of Industries with Market Power, In *Handbook of Industrial Organization*, Vol II, edited by R. Schmalensee and R.D. Willig, Elsevier Science Publishers 1989.
- Domowitz, Ian, Glen, Jack and Madhavan, Ananth (2000): Liquidity, Volatility, and Equity Trading Costs Across Countries and Over Time, Working Paper.
- Domowitz Ian and Steil Benn (1999): Automation, Trading Costs, and the Structure of the Trading Services Industry, *Brookings-Wharton Papers on Financial Services* 1999.
- Domowitz, Ian (2001): Liquidity, Transaction Costs, and Reintermediation in Electronic Markets, Working Paper.
- European Central Bank (2001): European Equity Markets, ECB Euro Equity Markets Report, August 2001.
- Economides, Nicholas and Heisler, Jeffrey (1994): Equilibrium Fee Schedules in a Monopolist Call Market, Working Paper.
- Economides, Nicholas and Schwartz, Robert A. (1995): Equity Trading Practises and Market Structure: Assessing Asset Managers' Demand for Immediacy, *Financial Markets, Institutions & Instruments*, Vol. 4 no. 4.
- Greene, William H. (2000): *Econometric Analysis*, 4th edition, Prentice Hall, 2000.

- Hasan, Iftekhar and Schmiedel, Heiko (2003): Do Networks in the Stock Exchange Industry Pay Off? European Evidence, *International Review of Financial Analysis*, forthcoming.
- de Jong, Frank, Nijman, Theo and Röell, Ailsa (1995): A Comparison of the Cost of Trading French Shares on the Paris Bourse and on SEAQ International, *European Economic Review* Vol. 39 pp. 1277-1301.
- McManus, Brian (2002): Nonlinear Pricing in an Oligopoly Market: The Case of Specialty Coffee, Olin School of Business Working Paper, March 2002.
- Mildenstein, Eckart and Schleef, Harold (1983): The Optimal Pricing Policy of a Monopolistic Marketmaker in the Equity Market, *Journal of Finance*, Vol. 38, No. 1, pp. 218-231.
- Miravete, Eugenio and Roller, Lars-Hendrik (2003): Competitive Non-Linear Pricing in Duopoly Equilibrium: The Early US Cellular Telephone Industry, CEPR Discussion Paper No. 4069, 2003.
- Mitchell, Bridger M. and Vogelsang, Ingo (1991): *Telecommunications Pricing: Theory and Practice*, Cambridge University Press 1991.
- Ordovery, Janusz A. and Panzar John C. (1980): On the Nonexistence of Pareto Superior Outlay Schedules, *The Bell Journal of Economics*, Vol 11, pp. 351-354.
- Oren, Shmuel S., Smith, Stephen A. and Wilson, Robert B. (1982): Nonlinear Pricing in Markets with Interdependent Demand *Marketing Science* Vol. 1, No. 3 Summer 1982 pp. 287-313.
- Oren, Shmuel S., Smith, Stephen A. and Wilson, Robert B. (1983): Competitive Nonlinear Tariffs, *Journal of Economic Theory*, Vol. 29, pp.49-71.
- Schmiedel, Heiko (2004): Performance of International Securities Markets, *Bank of Finland Studies E:28/2004*.
- Stoll, Hans R. (2001): Market Microstructure, Forthcoming in *Handbook of the Economics of Finance*.
- Wilson, Robert B. (1993): *Nonlinear Pricing*, Oxford University Press 1993.

Appendix 1 Derivation of profit maximization condition

The exchange's profit function can be written as a sum of profits from each purchase size category.

$$\pi_i = \sum_k \pi_{i,k}$$

$$\pi_{i,k} = \sum_k n_{i,k} [p_{i,k} - c] \rho_k$$

where $n_{i,k} = n_{i,k}(p_{i,k}, p_{j \neq i,k})$ is determined by the price of exchange i . The profit of exchange i in category k is maximized with respect to the price.

$$\frac{\partial \pi_{i,k}}{\partial p_{i,k}} = \left[n_{i,k} + (p_{i,k} - c_i) \frac{\partial n_{i,k}}{\partial p_{i,k}} \right] \rho_k = 0.$$

The relationship between the number of brokers and the price (that is the same for each category in the specification, $p_{i,k} = p_i$) can be obtained from the demand estimation specification $\log n_{i,k,t} = a_k - \beta_k \log p_{i,t} + d_k \text{trend}_t + u_{i,k}$ (subscript t is dropped):

$$\frac{\partial n_{i,k}}{\partial p_{i,k}} = - \frac{\beta_{i,k} n_{i,k}}{p_{i,k}}$$

Respectively, the profit-maximization condition can be written as:

$$\frac{\partial \pi_{i,k}}{\partial p_{i,k}} = \left[n_{i,k} - (p_{i,k} - c_i) \frac{\beta_{i,k} n_{i,k}}{p_{i,k}} \right] \rho_k = 0.$$

Hence, the condition for the optimal price for each category k can be presented as:

$$p_{i,k} = \frac{c_i}{\left(1 - \frac{1}{\beta_{i,k}} \right)}.$$

Category specific prices allow the construction of a non-linear price schedule. In order to determine optimal linear price for the aggregate demand the profit maximization condition can be written in the following way (i.e. it is assumed $p_{i,k} = p_i$):

$$\frac{\partial \pi_{i,k}}{\partial p_{i,k}} = \sum_k \left[n_k + (p_i - c_i) \frac{\partial n_k}{\partial p_i} \right] \rho_k = 0$$

Recalling that in the empirical specification $p_{i,k} = p_i$, the condition can be written as:

$$\frac{\partial \pi_{i,k}}{\partial p_{i,k}} = \sum_k n_k \rho_k \left[1 + \beta_{i,k} \frac{(p_i - c_i)}{p_i} \right] = \sum_k n_k \rho_k + \sum_k n_k \rho_k \left[\beta_{i,k} \frac{(p_i - c_i)}{p_i} \right] = 0$$

This can be simplified into the following form:

$$p_i = \frac{c_i}{\left(1 + \frac{1}{\sum_k n_k \rho_k \beta_{i,k} / \sum_k n_k \rho_k} \right)} = \frac{c_i}{\left(1 + \frac{1}{w \beta_{i,k}} \right)}$$

where the term $w \beta_{i,k}$ denotes a weighted average of category specific elasticities.

Appendix 2 Pricing schedules of the Helsinki stock exchange

	1998	1999	2000	2001	2002
Fixed fee for admission	16 818 €	20 000 €	20 000 €	21 700 €	21 700 €
Fee for membership	1 618€ per month	2 000€ per month	2 000€ per month	2 175€ per month	1 750€ per month
Fee based on number of trades	-	-	PRICE LIST I: first 10 000 trades/month 1,5€ per trade then 0,9€ per trade PRICE LIST II: 0,6€ per trade	PRICE LIST I: first 10 000 trades/month 1,63€ per trade then 0,98€ per trade PRICE LIST II: 0,65€ per trade	PRICE LIST I: first 10 000 trades/month 1,47€ per trade then 0,88€ per trade PRICE LIST II: 0,58€ per trade
Fee based on value of trades	Automated trade 0,0030% from 1000 lots 0,0025% After market 0,0040% from 1000 lots 0,0035%,	Automated trade 0,0030% from 1000 lots 0,0025%, Nokia 0,0025%, 10 000 lots or more 0,0030% After market 0,0040% from 1000 lots 0,0035%, Nokia 0,0040%	PRICE LIST I: Automated trade 0,0025%, Negotiated trade 0,0035%, After market 0,0035% PRICE LIST II: Automated trade 0,0032%, Negotiated trade 0,0042%, After market 0,0042%	PRICE LIST I: Automated trade 0,00272%, Negotiated trade 0,00381%, After market 0,00381% PRICE LIST II: Automated trade 0,00348%, Negotiated trade 0,00457%, After market 0,00457%	PRICE LIST I: Automated trade 0,00244%, Negotiated trade 0,00325%, After market 0,00325% PRICE LIST II: Automated trade 0,00313%, Negotiated trade 0,00411%, After market 0,00411%

Appendix 3 Estimation results for OLS models

Dependent Variable: Number of brokers (n)		Method: Ordinary Least-Squares																	
Independent Variables		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
<i>Constant</i>		3.163	3.167	3.019	2.769	2.625	2.526	2.357	2.240	2.192	2.183	2.241	2.361	1.838	1.680	1.850	1.296	0.948	0.928
		0.097	0.104	0.100	0.109	0.106	0.144	0.170	0.174	0.194	0.218	0.268	0.293	0.251	0.328	0.424	0.355	0.416	0.459
		***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
<i>Heisinki (β_1)</i>		0.268	0.309	0.233	-0.073	-0.202	-0.205	-0.332	-0.413	-0.354	-0.246	-0.135	0.089	-0.513	-0.599	-0.323	-0.909	-1.266	-1.204
		0.127	0.135	0.136	0.147	0.147	0.197	0.233	0.239	0.266	0.295	0.353	0.379	0.339	0.441	0.540	0.478	0.562	0.615
		**	**	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Trend (d)</i>		0.020	0.020	0.021	0.016	0.013	0.013	0.012	0.010	0.012	0.014	0.015	0.017	0.012	0.012	0.013	0.010	0.007	0.007
		0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.004	0.004	0.005	0.005	0.005	0.006	0.008	0.007	0.008	0.008
		***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
<i>AR(1)</i>		0.488	0.497	0.427	0.459	0.158	0.394	0.377	0.312	0.392	0.501	0.537	0.571	0.388	0.427	0.592	0.413	0.371	0.443
		0.149	0.160	0.143	0.147	0.163	0.159	0.161	0.158	0.154	0.153	0.148	0.146	0.151	0.154	0.142	0.156	0.162	0.163
		***	***	***	***	**	**	**	**	***	***	***	***	***	***	***	***	***	***
<i>R²</i>		0.949	0.943	0.938	0.925	0.855	0.857	0.802	0.748	0.764	0.801	0.749	0.748	0.734	0.692	0.693	0.692	0.659	0.669
Independent Variables		19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
in category k:																			
<i>Constant</i>		0.717	0.339	-0.214	-0.179	0.061	0.496	-0.519	1.072	1.530	1.861	1.193	0.947	-0.046	-1.305	-1.277	-1.459	-1.168	
		0.494	0.572	0.687	0.839	0.837	1.013	1.014	1.600	1.742	1.868	1.565	1.515	1.273	1.154	1.136	1.016	1.074	
		-1.362	-1.746	-2.154	-2.015	-1.559	-0.982	-2.133	-0.272	0.155	0.440	-0.147	-0.420	-1.386	-2.921	-2.923	-3.104	-2.666	
<i>Heisinki (β_1)</i>		0.669	0.771	0.935	1.106	1.094	1.214	1.305	1.425	1.349	1.340	1.371	1.286	1.455	1.531	1.502	1.371	1.437	
		**	**	**	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Trend (d)</i>		0.007	0.005	0.008	0.009	0.015	0.017	0.008	0.010	0.007	0.004	0.004	0.002	0.000	-0.011	-0.016	-0.017	-0.014	
		0.009	0.011	0.013	0.015	0.015	0.017	0.017	0.032	0.038	0.041	0.032	0.031	0.024	0.021	0.020	0.018	0.019	
		0.422	0.419	0.353	0.500	0.532	0.638	0.528	0.799	0.829	0.843	0.813	0.823	0.722	0.512	0.503	0.415	0.459	
<i>AR(1)</i>		0.161	0.160	0.162	0.155	0.157	0.142	0.162	0.124	0.173	0.106	0.110	0.108	0.128	0.160	0.162	0.162	0.167	0.162
		***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
<i>R²</i>		0.637	0.626	0.606	0.657	0.678	0.720	0.679	0.745	0.751	0.745	0.731	0.760	0.680	0.564	0.554	0.505	0.482	

Standard errors are reported in italics. ***, **, * indicate significance at the 1, 5, 10 percent levels respectively.

Appendix 4 Estimation results for SUR-system

Dependent Variable: Number of brokers (n)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Method: Seemingly Unrelated Regression																			
in category k:																			
<i>Constant</i>		3.217	3.220	3.086	2.801	2.668	2.524	2.394	2.334	2.326	2.334	2.355	2.478	1.909	1.844	1.850	1.469	1.099	1.077
		<i>0.074</i>	<i>0.076</i>	<i>0.068</i>	<i>0.073</i>	<i>0.070</i>	<i>0.087</i>	<i>0.107</i>	<i>0.108</i>	<i>0.125</i>	<i>0.132</i>	<i>0.152</i>	<i>0.162</i>	<i>0.131</i>	<i>0.180</i>	<i>0.210</i>	<i>0.199</i>	<i>0.204</i>	<i>0.238</i>
		***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
<i>Helsinki (β_1)</i>		0.341	0.379	0.321	-0.028	-0.154	-0.208	-0.282	-0.279	-0.165	-0.033	0.033	0.264	-0.399	-0.358	-0.294	-0.656	-1.038	-0.980
		0.098	0.102	0.091	0.097	0.093	0.115	0.142	0.144	0.162	0.168	0.195	0.198	0.170	0.229	0.257	0.249	0.257	0.300
		***	***	***	*	*	*	*	*	*	*	*	*	**	*	*	*	*	*
<i>Trend (d)</i>		0.021	0.021	0.022	0.016	0.013	0.013	0.012	0.012	0.014	0.016	0.016	0.019	0.013	0.015	0.014	0.013	0.010	0.010
		0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.004	0.003	0.004	0.005	0.005	0.005	0.006
		***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	*
<i>AR(1)</i>		0.449	0.385	0.294	0.332	0.135	0.267	0.269	0.189	0.344	0.429	0.415	0.504	0.223	0.345	0.457	0.355	0.250	0.348
		0.037	0.049	0.040	0.034	0.049	0.043	0.048	0.051	0.037	0.037	0.033	0.035	0.038	0.039	0.035	0.031	0.031	0.030
		***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
<i>R²</i>		0.949	0.943	0.936	0.923	0.854	0.854	0.798	0.740	0.759	0.794	0.739	0.743	0.722	0.683	0.684	0.687	0.648	0.661
Independent Variables		19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
in category k:																			
<i>Constant</i>		0.981	0.619	-0.012	-0.022	0.047	0.325	-0.065	0.969	1.312	1.667	0.964	0.563	-0.339	-1.248	-1.289	-1.289	-1.173	
		0.285	0.335	0.415	0.499	0.469	0.479	0.440	0.547	0.622	0.611	0.659	0.608	0.587	0.605	0.595	0.536	0.557	
		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>Helsinki (β_1)</i>		-0.980	-1.336	-1.854	-1.768	-1.547	-1.076	-1.414	0.028	0.406	0.816	-0.100	-0.558	-1.633	-2.812	-2.903	-2.836	-2.641	
		0.367	0.429	0.545	0.640	0.597	0.595	0.537	0.522	0.580	0.514	0.626	0.584	0.688	0.769	0.762	0.694	0.720	
		***	***	***	***	*	***	*	*	*	*	*	*	**	***	***	***	***	***
<i>Trend (d)</i>		0.011	0.010	0.012	0.012	0.016	0.020	0.017	0.025	0.024	0.024	0.014	0.010	0.002	-0.010	-0.015	-0.014	-0.013	
		0.006	0.008	0.009	0.011	0.011	0.011	0.011	0.016	0.018	0.019	0.019	0.019	0.018	0.015	0.014	0.013	0.012	0.013
		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
<i>AR(1)</i>		0.341	0.351	0.268	0.424	0.437	0.488	0.410	0.664	0.713	0.729	0.719	0.715	0.574	0.411	0.395	0.308	0.328	
		0.033	0.030	0.034	0.034	0.034	0.035	0.034	0.030	0.032	0.025	0.029	0.032	0.032	0.031	0.033	0.032	0.033	0.033
		***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
<i>R²</i>		0.627	0.618	0.600	0.652	0.674	0.710	0.660	0.731	0.739	0.731	0.724	0.752	0.668	0.557	0.547	0.495	0.470	

Standard errors are reported in italics. ***, **, * portray significance at the 1,5,10 percent levels respectively.

A-SARJA: VÄITÖSKIRJOJA - DOCTORAL DISSERTATIONS. ISSN 1237-556X.

- A:211. TOMMI KASURINEN: Exploring Management Accounting Change in the Balanced Scorecard Context. Three Perspectives. 2003. ISBN 951-791-736-8.
- A:212. LASSE NIEMI: Essays on Audit Pricing. 2003. ISBN 951-791-751-1.
- A:213. MARKKU KAUSTIA: Essays on Investor Behavior and Psychological Reference Prices. 2003. ISBN 951-791-754-6.
- A:214. TEEMU YLIKOSKI: Access Denied: Patterns of Consumer Internet Information Search and the Effects of Internet Search Expertise. 2003. ISBN 951-791-755-4.
- A:215. PETRI HALLIKAINEN: Evaluation of Information System Investments. 2003. ISBN 951-791-758-9.
- A:216. PETRI BÖCKERMAN: Empirical Studies on Working Hours and Labour Market Flows. 2003. ISBN 951-791-760-0.
- A:217. JORMA PIETALA: Päivittäistavara-kaupan dynamiikka ja ostokäyttäytyminen Pääkaupunkiseudulla. 2003. ISBN 951-791-761-9.
- A:218. TUOMAS VÄLIMÄKI: Central Bank Tenders: Three Essays on Money Market Liquidity Auctions. 2003. ISBN 951-791-762-7.
- A:219. JUHANI LINNAINMAA: Essays on the Interface of Market Microstructure and Behavioral Finance. 2003. ISBN 951-791-783-X.
- A:220. MARKKU SALIMÄKI: Suomalaisen design-teollisuuden kansainvälinen kilpailukyky ja kansainvälistyminen. Strateginen ryhmä – tutkimus design-aloilta. 2003 ISBN 951-791-786-4.
- A:221. HANNU KAHRA: Consumption, Liquidity and Strategic Asset Allocation. 2003. ISBN 951-791-791-0.
- A:222. TONI RIIPINEN: The Interaction of Environmental and Trade Policies. 2003. ISBN 951-791-797-X.
- A:223. MIKKO SYRJÄNEN: Data Envelopment Analysis in Planning and Heterogeneous Environments. 2003. ISBN 951-791-806-2.
- A:224. ERKKI HÄMÄLÄINEN: Evolving Logistic Roles of Steel Distributors. 2003. ISBN 951-791-807-0.
- A:225. SILJA SIITONEN: Impact of Globalisation and Regionalisation Strategies on the Performance of the World's Pulp and Paper Companies. 2003. ISBN 951-791-808-9.
- A:226. EIREN TUUSJÄRVI: Multifaceted Norms in SMC Export Cooperation: A Discourse Analysis of Normative Expectations. 2003. ISBN 951-791-812-7.

- A:227. MIKA MALIRANTA: Micro Level Dynamics of Productivity Growth. An Empirical Analysis of the Great Leap in Finnish Manufacturing Productivity in 1975-2000. 2003. ISBN 951-791-815-1.
- A:228. NINA KOISO-KANTTILA: Essays on Consumers and Digital Content. 2003. ISBN 951-791-816-X.
- A:229. PETER GABRIELSSON: Globalising Internationals: Product Strategies of ICT Companies. 2004. ISBN 951-791-825-9, ISBN 951-791-826-7 (Electronic dissertation).
- A:230. SATU NURMI: Essays on Plant Size, Employment Dynamics and Survival. 2004. ISBN 951-791-829-1, ISBN 951-791-830-5 (Electronic dissertation).
- A:231. MARJA-LIISA KURONEN: Vakuutusehtotekstin uudistamisprosessi, matkalla alamaisestä asiakkaaksi. 2004. ISBN 951-791-833-X, ISBN 951-791-834-8 (Electronic dissertation).
- A:232. MIKA KUISMA: Erileistuminen vai samanlaistuminen? Vertaileva tutkimus paperiteollisuusyhtiöiden ympäristöjohtamisesta. 2004. ISBN 951-791-835-6, ISBN 951-791-836-4 (Electronic dissertation).
- A:233. ANTON HELANDER: Customer Care in System Business. 2004. ISBN 951-791-838-0.
- A:234. MATTI KOIVU: A Stochastic Optimization Approach to Financial Decision Making. 2004. ISBN 951-791-841-0, ISBN 951-791-842-9 (Electronic dissertation).
- A:235. RISTO VAITTINEN: Trade Policies and Integration – Evaluations with CGE -models. 2004. ISBN 951-791-843-7, ISBN 951-791-844-5 (Electronic dissertation).
- A:236. ANU VALTONEN: Rethinking Free Time: A Study on Boundaries, Disorders, and Symbolic Goods. 2004. ISBN 951-791-848-8, ISBN 951-791-849-6 (Electronic dissertation).
- A:237. PEKKA LAURI: Human Capital, Dynamic Inefficiency and Economic Growth. 2004. ISBN 951-791-854-2, ISBN 951-791-855-0 (Electronic dissertation).
- A:238. SAMI JÄRVINEN: Essays on Pricing Commodity Derivatives. 2004. ISBN 951-791-861-5, ISBN 951-791-862-3 (Electronic dissertation).
- A:239. PETRI I. SALONEN: Evaluation of a Product Platform Strategy for Analytical Application Software. 2004. ISBN 951-791-867-4, ISBN 951-791-868-2 (Electronic dissertation).
- A:240. JUHA VIRRANKOSKI: Essays in Search Activity. 2004. ISBN 951-791-870-4, ISBN 951-791-871-2 (Electronic dissertation).
- A:241. RAUNI SEPPOLA: Social Capital in International Business Networks. Confirming a Unique Type of Governance Structure. 2004. ISBN 951-791-876-3, ISBN 951-791-877-1 (Electronic dissertation).
- A:242. TEEMU SANTONEN: Four Essays Studying the Effects of Customization and Market Environment on the Business Success of Online Newspapers in Finland. 2004. ISBN 951-791-878-X, ISBN 951-791-879-8 (Electronic dissertation).
- A:243. SENJA SVAHN: Managing in Different Types of Business Nets: Capability Perspective. 2004. ISBN 951-791-887-9.

- A:244. JUKKA MÄKINEN: John Rawlsin oikeudenmukaisuuskäsityksen merkitys normatiiviselle taloustieteelle. 2004. ISBN 951-791-889-5, ISBN 951-791-890-9 (Electronic dissertation).
- A:245. ERJA KETTUNEN: Regionalism and the Geography of Trade Policies in EU-ASEAN Trade. 2004. ISBN 951-791-891-7, ISBN 951-791-892-5 (Electronic dissertation).
- A:246. OLLI-PEKKA RUUSKANEN: An Econometric Analysis of Time Use in Finnish Households. 2004. ISBN 951-791-893-3, ISBN 951-791-894-1 (Electronic dissertation).
- A:247. HILPPA SORJONEN: Taideorganisaation markkinaorientaatio. Markkinaorientaation edellytykset ja ilmeneminen esitystaideorganisaation ohjelmistosuunnittelussa. 2004. ISBN 951-791-898-4, ISBN 951-791-899-2 (Electronic dissertation).
- A:248. PEKKA KILLSTRÖM: Strategic Groups and Performance of the Firm - Towards a New Competitive Environment in the Finnish Telecommunications Industry. 2005. ISBN 951-791-904-2, ISBN 951-791-905-0 (Electronic dissertation).
- A:249. JUHANI YLIKERÄLÄ: Yrityshautomokokemuksen vaikutukset tradenomiopiskelijan yrittäjäjäuran syntyyn ja kehittymiseen. Yrityshautomotoiminta liiketalouden alan ammattikorkeakoulun yrittäjäkoulutuksessa. 2005. ISBN 951-791-910-7.
- A:250. TUURE TUUNANEN: Requirements Elicitation for Wide Audience End-Users. 2005. ISBN 951-791-911-5, ISBN 951-791-912-3 (Electronic dissertation).
- A:251. SAMULI SKURNIK: Suomalaisen talousmallin murros. Suljetusta sääntelytaloudesta kaksinaapaiseen globaalitalouteen. 2005. ISBN 951-791-915-8, ISBN 951-791-916-6 (Electronic dissertation).
- A:252. ATSO ANDERSÉN: Essays on Stock Exchange Competition and Pricing. 2005. ISBN 951-791-917-4, ISBN 951-791-918-2 (Electronic dissertation).

B-SARJA: TUTKIMUKSIA - RESEARCH REPORTS. ISSN 0356-889X.

- B:44. ELINA HENTTONEN – PÄIVI ERIKSSON – SUSAN MERILÄINEN: Teknologiayrittämisen sukupuoli. Naiset miesten maailmassa. 2003. ISBN 951-791-737-6.
- B:45. KIRSI KORPIAHO: "Kyllä siinä pitää elää mukana!" Kirjanpitäjien tarinoita työstä, osaamisesta ja oppimisesta työyhteisönäkökulmasta analysoituna. 2003. ISBN 951-791-742-2.
- B:46. NIILLO HOME (toim.): Puheenvuoroja ECR-toiminnasta. Discussions on ECR – Summaries. 2003. ISBN 951-791-749-X.
- B:47. PÄIVI KARHUNEN – RIITTA KOSONEN – MALLA PAAJANEN: Gateway-käsitteen elinkaari Venäjän-matkailussa. Etelä-Suomi Pietarin-matkailun väylänä. 2003. ISBN 951-791-756-2.
- B:48. ANNELI KAUPPINEN – ANNE ARANTO – SATU RÄMÖ (toim.): Myyttiset markkinat. 2003. ISBN 951-791-771-6.
- B:49. MIKKO SAARIKIVI – SIMO RIIHONEN: Suomen puuteollisuuden kilpailukyvyyn parantaminen ja kansainvälistyminen piha- ja ympäristörakentamisessa. 2003. ISBN 951-791-779-1.

- B:50. KATARIINA KEMPPAINEN – ARI P.J. VEPSÄLÄINEN – JUKKA KALLIO – TIMO SAARINEN – MARKKU TINNILÄ: From Supply Chain to Networks: A Study of SCM Practices in Finnish Industrial Companies. 2003. ISBN 951-791-780-5.
- B:51. SAMI SARPOLA: Enterprise Resource Planning (ERP) Software Selection and Success of Acquisition Process in Wholesale Companies. 2003. ISBN 951-791-802-X.
- B:52. MATTI TUOMINEN (ed.): Essays on Capabilities Based Marketing and Competitive Superiority. Fimac II - Research: Mai Anttila, Saara Hyvönen, Kristian Möller, Arto Rajala, Matti Tuominen. 2003. ISBN 951-791-814-3.
- B:53. PÄIVI KARHUNEN – RIITTA KOSONEN – ANTTI LEIVONEN: Osaamisen siirtyminen Suomalais-venäläisissä tuotantoalliansseissa. Tapaustutkimuksia pietarista ja leningradin alueelta. 2003. ISBN 951-791-820-8.
- B:54. JARMO ERONEN: Kielten välinen kilpailu: Taloustieteellis-sosiolingvistinen tarkastelu. 2004. ISBN 951-791-828-3.
- B:47. PÄIVI KARHUNEN – RIITTA KOSONEN – MALLA PAAJANEN: Gateway-käsitteen elinkaari Venäjän-matkailussa. Etelä-Suomi Pietarin-matkailun väylänä. 2004. ISBN 951-791-846-1, korjattu painos.
- B:55. TAISTO MIETTINEN: Veron minimointi yritysjärjestelyissä. 2004. ISBN 951-791-856-9.
- B:56. SOILE TUORINSUO-BYMAN: Part-Time Work, Participation and Commitment. ISBN 951-791-866-6.
- B:57. PIIA HELISTE – RIITTA KOSONEN – KAROLIINA LOIKKANEN: Kaksoiskaupunkija vai kaupunkipareja? Tapaustutkimukset: Helsinki–Tallinna, Tornio–Haaparanta, Imatra–Svetogorsk. 2004. ISBN 951-791-886-0.
- B:58. JARMO ERONEN: Central Asia – Development Paths and Geopolitical Imperatives. 2005 ISBN 951-791-906-9.

E-SARJA: SELVITYKSIÄ - REPORTS AND CATALOGUES. ISSN 1237-5330.

- E:102. DAN STEINBOCK: The U.S. CIBER Experience: The Centers for International Business Education and Research (CIBERs). 2003. ISBN 951-791-781-3.

N-SARJA: HELSINKI SCHOOL OF ECONOMICS. MIKKELI BUSINESS CAMPUS PUBLICATIONS. ISSN 1458-5383

- N:15. ELINA HAVERINEN: Etelä-Savon pk-yritysten Viron kauppa. Ulkomaankaupan erityisraportti 2003. ISBN 951-791-732-5.
- N:16. REETA RÖNKKÖ: Latalainen Amerikka markkina-alueena Argentiina ja Brasilia. Ulkomaankaupan erityisraportti 2003. ISBN 951-791-733-3.
- N:17. JAAKKO VARVIKKO – JUHA SIIKAVUO: Koulutus, oppiminen ja akateeminen yrittäjyys.

2003. ISBN 951-791-745-7.

- N:18. ANNE GUSTAFSSON-PESONEN – SATU SIKANEN: Yrittäjäkoulutuksesta yrittäjäksi. 2003 ISBN 951-791-763-5.
- N:19. TOIVO KOSKI: Impact of a venture capitalists' value added on value of a venture. 2003. ISBN 951-791-764-3.
- N:20. LAURA HIRVONEN: Itävalta suomalaisyritysten markkina-alueena. 2003. ISBN 951-791-765-1.
- N:21. LAURA MALIN: Etelä-Savon pk-yritysten vienti Belgiaan. 2003. ISBN 951-791-766-X.
- N:22. JUKKA PREPULA: Ranska suomalaisten pk-yritysten vientikohteena. 2003. ISBN: 951-791-767-8.
- N:23. HENNA HUCZKOWSKI: Pk-yritysten perustaminen Puolaan. 2003. ISBN 951-791-768-6.
- N:24. HENNA KATAJA – LEENA MÄÄTTÄ: Kiina suomalaisen pk-yrityksen vientikohteena. 2003. ISBN: 951-791-769-4.
- N:25. KAROLIINA IJÄS: Etelä-Savon pk-yritysten vienti Puolaan. 2003. ISBN: 951-791-770-8.
- N:26. MARJO VAHLSTEN: Matkailupalvelujen markkinoinnin kehittäminen verkkoyhteistyön avulla. 2003. ISBN: 951-791-792-9.
- N:27. TUULI SAVOLAINEN: Slovakia suomalaisten pk-yritysten markkina-alueena. 2003. ISBN: 951-791-793-7.
- N:28. HARRY MAASTOVAARA: Etelä-Savon yritysten ulkomaankauppa 2001. 2003. ISBN: 951-791-794-5.
- N:29. RIIKKA PIISPA: Yhteistoiminnallisuus alueen taloudellisen kehityksen edellytyksenä. 2003. ISBN 951-791-795-3.
- N:31. HANNA PERÄLÄ: Etelä-Savon pk-yritysten vienti Ruotsiin. 2003. ISBN: 951-791-799-6.
- N:32. SATU SIKANEN – MAARIT UKKONEN: Etelä-Savon Venäjän-kauppa 2003. 2003. ISBN 951-791-800-3.
- N:34. TOIVO KOSKI – ANTTI EKLÖF: Uudenmaan yrityshautomoista irtaantuneiden yritysten menestyminen, Yrittäjien näkemyksiä yrityshautomotoiminnasta sekä selvitys "yrittämisestä Työtä 2000" –projektin asiakkaiden yritystoiminnasta. 2003. ISBN 951-791-805-4.
- N:36. MAARIT UKKONEN: Yrittäjyysmotivaatio ja yrittäjyysasenteet Helsingin kauppakorkeakoulun BScBa -tutkinto-opiskelijoiden ja Mikkelin ammattikorkeakouluopiskelijoiden keskuudessa. 2004. ISBN 951-791-874-7.
- N:37. MIKKO SAARIKIVI: Helsingin kauppakorkeakoulun henkilöstön yrittäjyysmotivaatio ja yrittäjyysasenteet vuonna 2004. 2004. ISBN 951-791-882-8.
- N:38. MIKKO SAARIKIVI: Helsinki-Tallinn: The Twin City of Science Interreg III A Project. 2004. ISBN 951-791-883-6.

- N:39. MIKKO SAARIKIVI: Tieteen kaksoiskaupunki Helsinki-Tallinna Interreg III A -projekti. 2004. ISB 951-791-884-4.
- N:40. TOM LAHTI: The Role of Venture Capital in Filling the Equity Gap. An Analysis of Policy Issues. 2004. ISBN 951-791-885-2.
- N:41. VESA KOKKONEN: Etelä-Savon yritysten ulkomaankauppa 2003. 2004. ISBN 951-791-897-6.
- N:42. MAARIT UKKONEN – MIKKO SAARIKIVI – ERKKI HÄMÄLÄINEN: Selvitys Uudenmaan yrityshautomoyritysten mentorointitarpeista. 2005. ISBN 951-791-900-X.

W-SARJA: TYÖPAPEREITA - WORKING PAPERS . ISSN 1235-5674.
ELECTRONIC WORKING PAPERS, ISSN 1795-1828.

- W:335. SATU NURMI: Sectoral Differences In Plant Start-up Size. 2003. ISBN 951-791-738-4.
- W:336. SATU NURMI: Plant Size, Age And Growth In Finnish Manufacturing. 2003. ISBN 951-791-739-2.
- W:337. PETRI HALLIKAINEN – HANNU KIVIJÄRVI: Appraisal of Strategic it Investments: Payoffs And Tradeoffs. 2003. ISBN 951-791-740-6.
- W:338. SENJA SVAHN: Knowledge Creation in Business Networks – A Dynamic-capability Perspective. 2003. ISBN 951-791-743-0.
- W:339. KRISTIAN MÖLLER – SENJA SVAHN: Role of Knowledge in the Value Creation in Business Nets. 2003. ISBN 951-791-744-9.
- W:340. ELI MOEN – KARI LILJA: European Works Councils in M-Real and Norske Skog: The Impact of National Traditions in Industrial Relations. 2003. ISBN 951-791-750-3.
- W:341. KJELD MÖLLER: Salatulla "arvopaperistamisella" tuhottiin yrittäjyyttä. 2003. ISBN 951 791-752-X
- W:342. ATSO ANDERSEN: Competition Between European Stock Exchanges. 2003. ISBN 951-791-753-8.
- W:343. MARKO MERISAVO: The Effects of Digital Marketing on Customer Relationships. 2003. ISBN 951-791-757-0.
- W:344. KLAUS KULTTI – JUHA VIRRANKOSKI: Price Distribution in a Random Matching Model. 2003. ISBN 951-791-759-7.
- W:345. PANU KALMI: The Rise and Fall of Employee Ownership in Estonia, 1987-2001. 2003. ISBN 951-791-772-4.
- W:346. SENJA SVAHN: Managing in Networks: Case Study of Different Types of Strategic Nets. 2003. ISBN 951-791-774-0.
- W:347. KRISTIAN MÖLLER – SENJA SVAHN: Crossing East-West Boundaries: Knowledge Sharing in Intercultural Business Networks. 2003. ISBN 951-791-775-9.

- W-348. KRISTIAN MÖLLER – SENJA SVAHN: Managing in Emergence: Capabilities for Influencing the Birth of New Business Fields. 2003. ISBN 951-791-776-7.
- W:349. TOM RAILIO: The Taxation Consequences of Scandinavian Mutual Fund Investments and After-Tax Performance Evaluation. 2003. ISBN 951-791-777-5.
- W:350. KIRSI LAPOINTE: Subjektiiivinen ura työurien tutkimuksessa ja teorioissa. 2003. ISBN 951-791-778-3.
- W:351. PANU KALMI: The Study of Co-operatives in Modern Economics: A Methodological Essay. 2003. ISBN 951-791-783-X.
- W:352. MARJA TAHVANAINEN: Short-term International Assignments: Popular Yet Largely Unknown Way Of Working Abroad. 2003. ISBN 951-791-784-8.
- W:353. MARKKU KUULA – ANTOINE STAM: An Interior Point Method for Multi-party Negotiation Support. 2003. ISBN 951-791-787-2.
- W:354. JOUKO KINNUNEN: Quantification of Ordered-level Business Sentiment Survey Forecasts by Means of External Validation Data. 2003. ISBN 951-791-790-2.
- W:355. TOM RAILIO: The Nature of Disagreements and Comparability Between Finnish Accumulating Mutual Funds and Voluntary Pension Insurances. 2003. ISBN 951-791-798-8.
- W:356. JUKKA JALAVA: 'Has Our Country the Patience Needed to Become Wealthy?' Productivity in the Finnish Manufacturing Industry, 1960-2000. 2003. ISBN 951-791-803-8.
- W:357. JARI VESANEN: Breaking Down Barriers for Personalization – A Process View. 2003. ISBN 951-791-804-6.
- W:358. JUHA VIRRANKOSKI: Search Intensities, Returns to Scale, and Uniqueness of Unemployment Equilibrium. 2003. ISBN 951-791-809-7.
- W:359. JUHA VIRRANKOSKI: Search, Entry, and Unique Equilibrium. 2003. ISBN 951-791-810-0.
- W:360. HANNA KALLA: Exploration of the Relationship Between Knowledge Creation, Organisational Learning, and Social Capital: Role of Communication. 2003. ISBN 951-791-813-5.
- W:361. PEKKA SÄÄSKILAHTI: Strategic R&D and Network Compatibility. 2003. ISBN 951-791-817-8.
- W:362. MAIJU PERÄLÄ: Allyn Young and the Early Development Theory. 2003. ISBN 951-791-818-6.
- W:363. OSSI LINDSTRÖM – ALMAS HESHMATI: Interaction of Real and Financial Flexibility: An Empirical Analysis. 2004. ISBN 951-791-827-5 (Electronic working paper).
- W:364. RAIMO VOUTILAINEN: Comparing alternative structures of financial alliances. 2004. ISBN 951-791-832-1 (Electronic working paper).
- W:365. MATTI KELOHARJU – SAMULI KNÜPFER – SAMI TORSTILA: Retail Incentives in Privatizations: Anti-Flipping Devices or Money Left on the Table? 2004. ISBN 951-791-839-9 (Electronic working paper).

- W:366. JARI VESANEN – MIKA RAULAS: Building Bridges for Personalization – A Process View. 2004. ISBN 951-791-840-2 (Electronic working paper).
- W:367. MAIJU PERÄLÄ: Resource Flow Concentration and Social Fractionalization: A Recipe for A Curse? 2004. ISBN 951-791-845-3 (Electronic working paper).
- W:368. PEKKA KORHONEN – RAIMO VOUTILAINEN: Finding the Most Preferred Alliance Structure between Banks and Insurance Companies. 2004. ISBN 951-791-847-X (Electronic working paper).
- W:369. ANDRIY ANDREEV – ANTTI KANTO: A Note on Calculation of CVaR for Student's Distribution. 2004. ISBN 951-791-850-X (Electronic working paper).
- W:370. ILKKA HAAPALINNA – TOMI SEPPÄLÄ – SARI STENFORS – MIKKO SYRJÄNEN – LEENA TANNER : Use of Decision Support Methods in the Strategy Process – Executive View. 2004. ISBN 951-791-853-4 (Electronic working paper).
- W:371. BERTTA SOKURA: Osaamispääoman ulottuvuudet. Arvoa luova näkökulma. 2004. ISBN 951-791-857-7 (Electronic working paper).
- W:372. ANTTI RUOTOISTENMÄKI – TOMI SEPPÄLÄ – ANTTI KANTO: Accuracy of the Condition Data for a Road Network. 2004. ISBN 951-791-859-3 (Electronic working paper).
- W:373. ESKO PENTTINEN: Bundling of Information Goods - Past, Present and Future. ISBN 951-791-864-X. (Electronic working paper).
- W:374. KASIMIR KALIVA – LASSE KOSKINEN: Modelling Bubbles and Crashes on the Stock Market. ISBN 951-791-865-8 (Electronic working paper).
- W:375. TEEMU SANTONEN: Evaluating the Effect of the Market Environment on the Business Success of Online Newspapers. 2004. ISBN 951-791-873-9 (Electronic working paper)
- W:376. MIKKO LEPPÄMÄKI – MIKKO MUSTONEN: Signaling with Externality. 2004. ISBN 951-791-880-1 (Elektronic working paper).
- W:377. MIKKO LEPPÄMÄKI – MIKKO MUSTONEN: Signaling and Screening with Open Source Programming. 2004. ISBN 951-791-881-X (Electronic working paper).
- W:378. TUURE TUUNANEN – KEN PEFFERS – CHARLES E. GENGLER: Wide Audience Requirements Engineering (Ware): A Practical Method And Case Study. 2004. ISBN 951-791-889-5. (Electronic working paper).
- W:379. LARS MATHIASSEN – TIMO SAARINEN – TUURE TUUNANEN – MATTI ROSSI: Managing Requirements Engineering Risks: An Analysis and Synthesis of the Literature. 2004. ISBN 951-791-895-X (Electronic working paper).
- W:380. PEKKA KORHONEN – LASSE KOSKINEN – RAIMO VOUTILAINEN: Finding the Most Preferred Alliance Structure between Banks and Insurance Companies from a Supervisory Point of View. 2004. ISBN-951-791-901-8 (Electronic working paper).
- W:381. PEKKA J. KORHONEN – PYYRY-ANTTI SIITARI: Using Lexicographic Parametric Programming for Identifying Efficient Units in Dea. 2004. ISBN 951-791-902-6. (Electronic working paper).

W:382. PEKKA MALO – ANTTI KANTO: Evaluating Multivariate GARCH models in the Nordic Electricity Markets. 2005. ISBN 951-791-903-4 (Electronic working paper).

W:383. OSSI LINDSTRÖM – ALMAS HESHMATI: Interacting Demand and Supply Conditions in European Bank Lending. 2005. ISBN 951-791-903-4 (Electronic working paper).

Y-SARJA: HELSINKI SCHOOL OF ECONOMICS.
CENTRE FOR INTERNATIONAL BUSINESS RESEARCH. CIBR RESEARCH PAPERS.
ISBN 1237-394X.

Y:8. REIJO LUOSTARINEN – MIKA GABRIELSSON: Globalization and Marketing Strategies of Born Globals in SMOPECs. 2004. ISBN 951-701-851-8.

Z-SARJA: HELSINKI SCHOOL OF ECONOMICS.
CENTRE FOR INTERNATIONAL BUSINESS RESEARCH. CIBR WORKING PAPERS. ISSN 1235-3931.

Z:10. V.H. MANEK KIRPALANI – MIKA GABRIELSSON: Need for International Intellectual Entrepreneurs and How Business Schools Can Help. 2004. ISBN 951-791-852-6.

Kaikkia Helsingin kauppakorkeakoulun julkaisusarjassa ilmestyneitä julkaisuja voi tilata osoitteella:

KY-Palvelu Oy
Kirjakauppa
Runeberginkatu 14-16
00100 Helsinki
Puh. (09) 4313 8310, fax (09) 495 617
Sähköposti: kirjak@kyypari.hkkk.fi

Helsingin kauppakorkeakoulu
Julkaisutoimittaja
PL 1210
00101 Helsinki
Puh. (09) 4313 8579, fax (09) 4313 8305
Sähköposti: julkaisu@hkkk.fi

All the publications can be ordered from

Helsinki School of Economics
Publications officer
P.O.Box 1210
FIN-00101 Helsinki
Phone +358-9-4313 8579, fax +358-9-4313 8305
E-mail: julkaisu@hkkk.fi