Investment Behavior of Stock Exchanges and the Rationale for Demutualization - Theory and Empirical Evidence

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Abstract

This paper deals with two, potentially intertwined issues of stock exchange governance. First, we demonstrate in a static global games model that investment propensity will vary across different types of organizational forms and competition scenarios. Exchanges organized as mutuals are particularly ill-suited compared to trading venues owned by outside investors, when investments result in potential rents for only few of their members. These circumstances are likely when exchanges invest in related business activities such as derivatives trading, post-trading and software development services. Second, we explain in a dynamic overlapping-generations framework the rationale for the recent wave of *demutualization*, which describes the process of converting a mutual, not-for-profit stock exchange into an outsider-owned, commercial firm. Our model shows that a mutual exchange, facing competition from a for-profit, outsider-owned platform, can only survive by adopting a similar governance structure. Our paper will also provide empirical evidence for the two main predictions derived from the models. For that purpose, we employ bivariate probit regressions to simultaneously estimate the propensity to invest and to demutualize, thereby accounting for potential endogeneity issues. We show that competitive pressure indeed increases the likelihood of demutualization and that outsider-owned exchanges have a stronger propensity to invest into related business activities.

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1 Introduction

The stock exchange industry has been subject to unprecedented dynamics in recent decades, particularly in Europe and the US. Overall competitive pressure increased on many stock exchanges due to a range of significant changes of the industry environment. Besides globalization tendencies that led to less home-biased investors and issuers and consequently stronger competition between national exchanges for order-flow and listings, the deregulation of financial markets resulted in lower barriers to entry, making the incumbents' home markets more contestable. A major catalyst for increased competitive pressure are also advances in communication and information technology, creating new forms to conduct business in this industry. Remote membership, electronic order book trading, alternative trading systems, and the internalization of order flow by financial intermediaries all became viable threats to the core business of stock exchanges, i.e. the traditional floor trading activity.

Furthermore, the trading members of the exchanges have become increasingly heterogeneous in nature. On the one hand, they differ in the activity they perform at the exchange. As an example one should think of brokers, dealers or broker-dealers, each with diverging preferences on exchange-related issues such as the imposed fee structure or the investments undertaken. On the other hand, members also vary in size and the scope of activities outside the exchanges. Some banks, for example, are engaged in activities such as over-the-counter trading, derivatives trading and post-trading services. To the extent that exchanges were also active in these fields, they became competitors of the exchanges.

Increased competition and divergence in the interests of the trading members led to a decline in the prosperity of stock exchanges. Some of them arrived at a point where their viability was at stake. In many cases, this resulted in a restructuring of their governance system, a process which is usually denoted as *demutualization*. As a consequence, their organizational form converted from the traditional mutual structure towards a regular outsider-owned, for-profit corporation. Take as an example the New York Stock Exchange (NYSE), whose seat price, a proxy for the profitability of possessing a licence to trade on the Big Board, declined sharply in the last years because of ever-growing pressure from competing trading venues and its members' resistance to implement a modern trading platform. Recently, the NYSE announced its demutualization and the successive migration towards electronic trading. Since March 2006, the exchange has floated its shares on its own market.

Meanwhile, new business opportunities emerged, partly due to the same technological advances that threatened the exchanges' core business. Exchanges could for example embrace the new IT technology to modernize their trading and information dissemination systems. This promised lower transaction costs and potentially higher rents for their members. Furthermore, related business activities that offered both growth opportunities and new sources of income induced exchanges to diversify into these fields. Vertical integration of post-trading services, for example, was easier to accomplish with the availability of modern IT-systems and promised efficiency gains due to straight-through-processing possibilities. The strong growth in the derivatives market induced many exchanges to horizontally integrate this business field by offering a derivatives trading platform.

Hence, the industry seems to experience both a trend towards demutualization and diversification into related business activities. Figure 1 confirms this notion for the 50 largest stock exchanges that report to the World Federation of Exchanges (FIBV). The left panel shows the number of exchanges according to their governance regime for the years 1999 to 2003. It becomes clear that the number of exchanges that are organized as mutuals, or are state-controlled, decreased substantially from 40 to only 25. In the same time period, the number of demutualized exchanges has increased from 10 to 25. Note that we distinguish between demutualized and publicly listed exchanges. The main difference between the two groups is that the latter not only underwent a demutualization process, but also sought a public listing. This will be relevant in the following, as the two groups differ in the type of owners they possess.

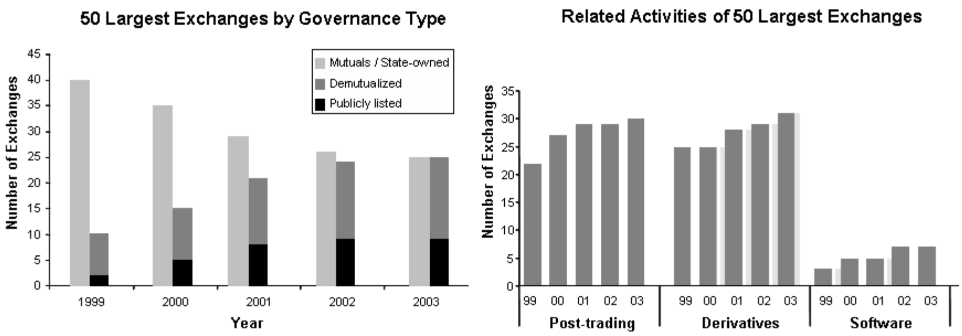

Figure 1: Organizational Form and Diversification of Stock Exchanges 1999-2003

The right panel shows the increase in diversification activity for the same sample of exchanges. The number of exchanges that added post-trading services to their business portfolio rose from 22 to 30, while the number of entities that operate a derivatives trading platform marked up from 25 to 31. Despite the strongest relative increase, providers of software solutions remained rather scarce, with three exchanges offering this service in 1999 and seven in 2003.

A preliminary event-study An obvious question seems whether there is a link between the two trends. One could argue that, since demutualized exchanges are profit-oriented entities, they are more likely to invest into related business segments to increase their revenues (and possibly profits, too). Figure 2 seeks to provide some preliminary empirical evidence by presenting two small 'event-studies'. We compare both the average degree of diversification and the development in operating revenues of exchanges that underwent a governance restructuring with entities that remained organized as mutuals. Without laying out the full details of the employed methodology at this point - we provide a detailed description in appendix F - the graphs make clear that the change in governance, especially for exchanges that went public, did have a profound effect on both dimensions.

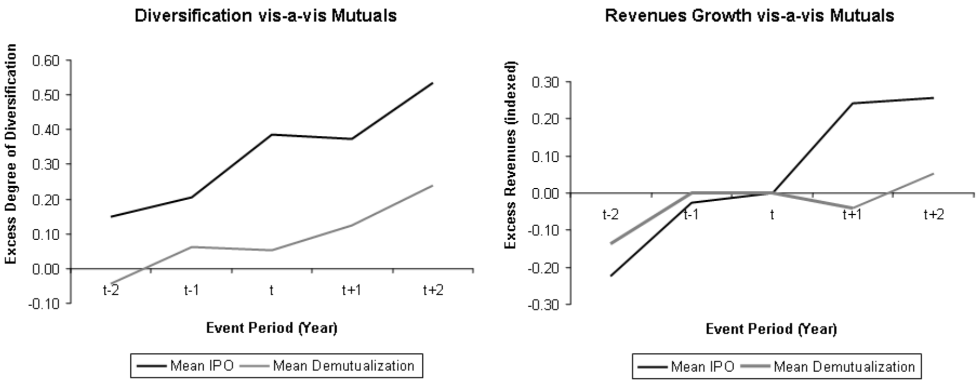

Figure 2: Event Studies on Governance Changes

The left graph shows that the average excess degree of diversification increased after the event of demutualizing and going public in period t, where one period equals one year, respectively. Note that exchanges that experienced such an 'event' have already been more diversified on average than the control sample of mutual exchanges prior to the event. This can be seen by the fact that both lines are in positive territory in period t-1. However, as our graph indicates, we still witness a significant rise in our measure after the event period.[1]

A somewhat similar picture provides the right graph, especially for publicly listed exchanges. Here, the indexed development in operating revenues for exchanges that either demutualized or went public are adjusted for the development in revenues of the control group of mutuals. As can be seen, publicly listed exchanges have outpaced their mutual counterparts on average after their respective IPO (at period t), whereas demutualized exchanges did not experience any significant excess rise in their revenues. We argue that the lion's share of the increase in revenues stems from these new related activities. Although one could propose that exchanges may have also earned more from the traditional cash market operation, our data lends only limited support to this notion.[2]

Our contribution and main findings The purpose of the first part of the paper is to provide a theory that explains the diverging investment behavior of exchanges and trading platforms[3] with different governance regimes. To model this, we build on a simplified version of Rey and Tirole (2000) which we adapt and extend to

[1]Note that some of the exchanges that underwent the demutualization process are also part of the IPO-sample as they went public a short period of time after their demutualization. Thus, the IPO-means partly show the development of the very same demutualized exchanges, which however, does not affect the validity of our statement advanced here.

[2]There has been an exceptional rise in revenues from cash trading-related activities by some smaller exchanges. Oslo Exchange, for example, increased its trading-related revenues from 1999 until 2004 by more 80%, the Wiener Börse by even 350% in the same time period. Yet, for the majority of the exchanges in our sample, we did not observe a significant rise in cash-trading revenues.

[3]We will use the terms trading platforms and exchanges synonymously.

certain characteristics of stock exchanges. In a static model, we analyze the competition between stock exchanges and their investment behavior. In our basic setup with homogeneous users, both competitors are considering to invest in an innovation which improves their trading technology and provides uniformly distributed benefits to all users. The investment is value-enhancing for their users, if the (fixed) costs can be recouped by charging a transaction fee on a sufficiently large trading volume. We show that in competition with an outsider-owned stock exchange, the mutual exchange is typically at a disadvantage. Our argument mainly bases on the idea that the latter has no financial buffer provided by outside investors and therefore has to pass on its investment costs to its members, irrespective of the trading volume that remains on its platform. Consequently, the mutual exchange is exposed to the possibility of runs, as a member's exit exerts a negative externality on the remaining members. We show that, in most circumstances, the outsider-owned exchange can exploit this fragility, thereby undermining the ability of the mutual exchange to invest, despite the existence of a countervailing "second-sourcing"-effect, which supports the investment propensity of a mutual. Second-sourcing connotes a situation where the mutual exchange invests into the project, even though it knows that its members will migrate to the competing for-profit exchange. The reason for this is that the mutual can improve the price conditions of the transfer for its members by investing into the project.

Introducing heterogeneity of members into the model confirms our results, when a majority of members experience a negative externality from the investment project.[4] We argue that this extension of the model structure should be interpreted as investments in related non-core business activities of an exchange, whose potential benefits are not distributed evenly across different types of members. This aspect of our model has important practical implications, as industry participants are concerned about certain investments undertaken by exchanges, such as the vertical integration of post-trading services, which are profitable for the exchange, but may be detrimental to its users. In Europe, outsider-owned Deutsche Börse, which bought post-trading services provider Clearstream in 2003, is therefore under particular scrutiny by both users and regulatory authorities due to fears of anti-competitive behavior.[5] The results from our model underline the fact that outsider-owned exchanges are less constrained in their investment behavior, which could lead to overall welfare losses, if the negative externalities borne by the users are larger than the gains for the exchange and its owners.

Furthermore, we will extend our basic model to a dynamic setting to analyze the options of an incumbent mutual exchange to survive in a competitive environment. To answer this question, we incorporate a standard overlapping generations framework into our model. This allows us to investigate the viability of a mutual exchange, which competes against an outsider-owned exchange. We show that when experiencing fierce competition from a for-profit trading platform, a mutual

[4] If a majority of members benefits from the project, we interestingly observe a higher investment propensity than for the case with homogeneous users, albeit lower than at an outsider-owned exchange.

[5] Several academic contributions have addressed this issue. Confer for example Tapking and Yang (2004) and Köppl and Monnet (2003).

exchange can only survive if it converts to a similar governance regime. This result hence provides a rationale for the recent wave of demutualization amongst exchanges that were exposed to increased competitive pressure.

In the second part of the paper we present empirical evidence for the main results derived from our model. For that purpose, we hand-collect information on the business model, competitive situation and governance regime for a sample of 26 stock exchanges in the time period 1999-2003. We then formulate two hypotheses that are linked to the main predictions from our theoretical part: Our first hypothesis tests whether competitive pressure increases the likelihood of demutualization, whereas our second hypothesis evaluates whether demutualized exchanges are more likely to invest in non-core business activities. In order to account for potential endogeneity problems between our governance, competition and business model variables, we use bivariate Probit regressions that simultaneously estimate our two hypotheses. Our results provide strong support for our stated hypotheses.

Related literature Our paper is related to different strands of the theoretical and empirical literature. First of all, the theoretical literature on mutuals and cooperatives is relevant. However, due to the large volume of contributions, we will merely be able to discuss selected contributions that are closely related to organizational forms of stock exchanges.[6]

One of the most cited papers in this area is by Hart and Moore (1996) (see in addition Hart and Moore (1998) for a more general approach). Focusing on the user welfare of different governance setups for stock exchanges, the authors analyze the relative merits of a mutual structure and outside ownership in dependence of the level of competition and the diversity of member interests. They obtain two main results: (1) Outside ownership becomes more efficient than a mutual structure as the members of the mutual become more diverse in terms of preferences. (2) Outside ownership becomes more efficient than a mutual structure as the exchange faces more competition. In contrast to our theoretical approach they do not explicitly analyze competitive interaction between stock exchanges with different organizational forms, nor do they investigate dynamic considerations that concern the viability of stock exchanges under competitive pressure.

Pirrong (2000) takes a different approach to analyze governance issues. In contrast to Hart and Moore (1996), he does not compare different owners of the exchange, but focuses on different types of users that may organize their stock exchange either as a for-profit or as a not for-profit entity. He then describes governance mechanisms to mitigate conflicts of interests between the members. In Pirrong (1999) and Pirrong (2002), an analysis of competition between stock exchanges is provided and is based on switching costs and liquidity effects, respectively. In contrast to our analysis, these papers do not deal with the issue of investment incentives and they do not consider explicitly competition between different organizational forms.

Our theoretical analysis has similarities to the theoretical analysis of two-sided

[6]For a very impressive analysis of cooperatives in general, see Hansmann (1996). Holmström (1999) and Fulton (1999) provided more recent, theoretically inspired contributions.

markets (see Armstrong (2005) and Rochet and Tirole (2005) for an overview). Furthermore, we build on two contributions by Patrick Rey and Jean Tirole, who analyze similar effects to the one described here in the payment card industry.[7] We adapt this approach to the stock exchange industry and extend their analysis in certain aspects. In particular, we explore investment decisions which have a heterogenous impact on the welfare of stock exchange users. We also investigate in more detail the investment incentives of different organizational forms and their viability under competitive pressure in an overlapping generations framework. In addition, based on the global games framework developed by Carlsson and van Damme (1993), we provide an analysis of the fragility of mutual exchanges that incorporates coordination problems of the exchanges' members.

The number of empirical papers on the governance of stock exchanges is relatively small. Krishnamurti, Sequeira, and Fangjian (2003) analyze the market quality of exchanges with different organizational form. They find evidence that the demutualized National Exchange of India provides a higher market quality than the mutual Bombay Stock Exchange. Mendiola and O'Hara (2003) focus on the post-IPO performance of publicly listed exchanges and find that these exchanges outperform both the general market and other IPOs. Furthermore, they find evidence for a positive link between the fraction of equity sold to outside investors and stock exchange performance. Yet, their findings are confined to the group of publicly listed exchanges and cannot provide any comparison to exchanges that are not outsider-owned. Other empirical attempts to compare different governance regimes in the stock exchange industry mainly rely on frontier efficiency methods. While Schmiedel (2001) employs a parametric stochastic frontier model to evaluate the cost efficiency of European stock exchanges, he applies a non-parametric method in a second paper (Schmiedel (2002)). The former paper controls for demutualized exchanges within the regression and displays a positive impact of demutualization on cost efficiency.[8] In his second paper, the mean of factor productivity gains is higher among mutual exchanges.

A recent paper by Ramos (2005) employs univariate Probit regressions to evaluate the propensity of exchanges to demutualize. It finds evidence that competitive pressure has a positive effect on the likelihood of exchanges to demutualize. Our paper has most similarities to the analysis of Ramos (2005) as we will also conduct Probit regressions to analyze the influence competition has on the decision of exchanges to demutualize. However, we need to employ a more involved estimation technique. As we also seek to provide evidence for the impact of organizational forms on investment decisions at exchanges, we use a bivariate Probit approach to account for potential endogeneity issues stemming from our governance variable.

The paper is structured as follows. Section 2 presents our model and states our propositions. Section 3 formulates the hypotheses, which we want to test, discusses the data and methodology employed, and finally presents our empirical results. Section 4 concludes.

[7]See Rey and Tirole (2000) and Rey and Tirole (2001). Rochet and Tirole (2002) provides a very interesting analysis of the competitive structure of the payment-card industry.

[8]Confer Schmiedel (2001, p.22)

2 Model

2.1 The basic setup

Competition, trading volume and users We are considering two exchanges X_1 and X_2, which both operate a proprietary trading platform. Initially, each of them has the same (large) number of identical users. We normalize the number of the users to a continuum of mass 1, such that we have customers of mass 2 in this economy, equally distributed on both systems.[9] We assume that the exchange's respective customers have made platform-specific investments in the past in order to access the trading venues. Therefore, we consider each exchange's customers as its respective installed base. These customers can be dealers, brokers, dealer-brokers, and banks, who use the trading platform of the exchange to execute trades for themselves and/or on behalf of the investing public.[10]

Initially, both exchanges have the same size in terms of trading volume, i.e. their customers generate a total trading volume of $v > 0$, respectively, which cannot be moved to another trading platform. To introduce competition in our model, we assume that the users possess an additional trading volume k, which can be transferred to the rival exchange without switching costs. We interpret this as the growth in trading volume. Hence, the higher the ratio k/v, the higher the degree of potential competition between X_1 and X_2. By introducing a fixed and a transferable component of trading volume, we want to grasp home-bias effects and other restraints in our model, which typically limit the degree of competition in the stock exchange industry.[11] This is due to the stickiness of trading volume at platforms that offer the highest level of liquidity in a certain security and which makes it very difficult to transfer it to a new exchange.

Investment project The trading costs that are incurred will determine the competitiveness of stock exchanges. To fix ideas, let us assume that, initially, both exchanges possess per unit transaction costs equal to c. In addition, both exchanges can invest in a project with fixed investment costs I and a gross surplus of θ for

[9] In the following, the terms "customers" and "users" of a stock exchange are synonymously.

[10] We do not explicitly analyze competition effects among the customers in the "downstream" market for the end-users of the exchange, e.g. retail traders and non-financial companies. In that respect we are quite agnostic. To simplify matters, we assume that trading volume and rents of the users will not be influenced by the trading fees charged by an exchange. Since we are not considering social welfare aspects and our main focus lies on the analysis of competition among exchanges, our results go through as long as we have some market imperfections on the end-user market. See Hausman, Leonard, and Tirole (2003) for an in-depth analysis of competition effects in the credit-card industry in a "double-differentiation" framework with systems differentiated as in Hotelling's model and end-users, i.e issuers, differentiated as in the Lerner-Salop model.

[11] Many countries just have one national stock exchange with an overwhelming market share in the trading of domestically listed companies. In these cases, competition comes merely from foreign exchanges, OTC-trading and intermediaries that internalize client orders.

each user.[12] We assume that the following investment condition holds:

$$v\theta < I < (v+k)\theta. \quad (1)$$

This condition states that the investment should be undertaken if an exchange not only attracts the fixed base volume v, but also at least the transferable volume k of its own users. However, the investment is not profitable if the exchange only retains the fixed volume v. We have chosen a general formulation for the gross surplus θ from the investment project, since the investment opportunity will be interpreted in different ways. For instance, it could be viewed as a technical improvement of the exchange's cash trading operations (e.g. its trading technology) such that the trading costs c are reduced by $\theta = c - c'$. Alternatively, the investment could take place in related business activities as described in the introduction, thereby producing less specified *rents* $(v+k)\theta$, which we assume to be proportional to the trading volume as well. However, there is one distinction between the two types of investment projects: Typically, the former investment project has a *homogeneous* influence on the users such that each user can potentially gain θ per trading unit. The latter investment opportunity, on the other hand, may have a *heterogeneous* impact in the sense that the distribution of rents is not uniform across all users. This captures the notion that an investment into related activities may create different externalities on the business activities of the various types of users (e.g. brokers, dealers, or banks). Thus, while $(v+k)\theta$ still represents total surplus, for different user-groups j, the impact θ_j may vary. Consequently, our notation in this case will be $\sum_{j=1}^{n} y_j\theta_j \equiv E[\theta] = \theta$, with y_j denoting the mass of the user-group j in the whole population of users of the exchange and the expected surplus equaling to the θ, as in the homogeneous case. We assume the θ_j's to be private information of each user, while the composition of θ is common knowledge.[13]

Characteristics of organizational forms Our model considers two exchanges that compete for the transferable trading volume of their members. The exchanges are either organized as not for-profit, member-owned mutuals or as outsider-owned, for-profit firms. There are three stylized distinctions between the two organizational forms:

1. Control structure: In the case of a mutual exchange, the customers/members are also the owners of the exchange and take decisions according to a democratic one-member, one-vote scheme. Hence, the mutual exchange acts in the customers' interest by maximizing their expected benefits. As long as the impact of the considered investment is homogeneous for all members, the decision of the exchange is taken unanimously. In case of heterogeneity, which

[12] In the basic model, we assume that there are no differences among the exchanges in the surplus of the available investment projects. However, this does not imply that the investment projects are necessarily identical. Instead, each project is adapted to the trading technology the respective exchange uses. With this assumption we want prevent that our results are biased by the nature of the project.

[13] By incorporating heterogeneity and private information into the model, our model has features of the model by Hart and Moore (1996).

we model in the simplest possible way with two types of users, i.e. y_j with $j = h, l$, the decision rights rest with the member group y_j that possesses the majority.[14] In contrast, an outsider-owned, for-profit exchange acts in the interest of its investors and does not take into account the potential externalities that may emerge for the exchange's customers. Outside owners are exclusively interested in the profitability of a project and will decide accordingly.

2. Price discrimination: Mutuals cannot discriminate among their members in terms of the trading fees. In contrast, outsider-owned exchanges are not constrained in the use of price discrimination. They may charge different prices for different customers.

3. Access to finance sources: A mutual's budget must be balanced ex post, regardless of the volume allocated to its trading platform, as it operates on a break-even basis and cannot make use of outside capital. Since the costs of a potential investment have to be financed via trading fees, the mutual exchange will set the transaction price according to the trading volume that was generated on its platform. Such a financing mode starkly contrasts with that of an outsider-owned, for-profit exchange, which can rely on the cushion provided by equity and long-term debt, if the costs of the investment project exceed the amount of received trading fees.

Time structure of investment decisions Our time structure will be typical for a long-term investment, which needs "time to build". Our model has three time periods:

Time period 0: The exchanges decide whether to undertake an investment and announce their trading fee level a to be charged in period 2.

Time period 1: The customers of the exchanges non-cooperatively decide where to allocate their transferable volume k.

Time period 2: The projects, if taken, are realized. The exchanges charge their trading fees.

Due to the different financing patterns outlined above, the time structure will have the following important implications: (1) A mutual that is considering to invest into the project has to bear in mind that the project's attractiveness critically depends on whether its users channel their additional trading volume to the exchange. A diversion of volume by some members to a competing exchange would leave the volume of the remaining members exposed to larger trading fees, as the fixed costs of the project have to be financed exclusively by this source. This in turn may trigger further diversion of trading volume. As the trading fees will be determined by the budget balance constraint, negative network externalities and coordination problems emerge. Consequently, the mutual exchange cannot bind itself

[14]For the general case with several types of member interests, the median voter-rule should be applied.

to its announcement a in period 0 and is therefore exposed to runs.[15] In essence, irrespective of what it announces in period 0, its fee will ultimately be determined by the retained volume in period 2. (2) The for-profit exchange on the other hand can credibly commit to its announcement in time period 0, as its outside investors serve as residual claimants if an unexpected event arises, such as insufficient trading volume, which needs a financial buffer. In essence, the varying financing patterns introduce different degrees of *commitment* to the announcement of trading fees to the model. This creates a competitive edge for the outsider-owned exchange, which we will outline in the following sections.

Structure of the theoretical part of the paper Given this setup, in section 2.2.1, we analyze how a mutual's investment behavior is affected by different competition scenarios. Thus, we evaluate its propensity to invest when it faces competition for the transferable volume k from no other exchange, another mutual, and an outsider-owned exchange. We will initially focus on an environment with homogeneous users, so that the undertaken projects are interpreted as investments into the core business activity of exchanges, i.e. the cash trading business. In section 2.2.2, we analyze the same question with respect to investments in related activities, which have a heterogenous impact on users. Section 2.2.3 concludes our analysis of the static case by presenting the results graphically. In section 2.3, we enrich our basic setup with a dynamic overlapping generations model to investigate the long-run viability of a mutual exchange that competes against an outsider-owned exchange. Propositions at the end of each section summarize our findings.

2.2 The static model - Investment propensity of exchanges

2.2.1 Competition between stock exchanges with homogeneous users

No competition As an introductory case, we briefly describe the situation, where neither exchange has the possibility to attract the transferable volume k from the customers of the rival exchange, i.e. when the exchanges face no competition. In this case, each exchange will invest into the efficiency-enhancing technology, as it knows that it will receive the transferable volume k with certainty. According to condition (1) the investment is worthwhile for each exchange delivering a surplus of $\theta(v+k) - I$. In case of two mutual exchanges, this means that the trading costs will be lowered to

$$\hat{a} \equiv c - (\theta - \frac{I}{v+k}) < c. \tag{2}$$

Competition between two mutuals More interesting is the case in which two mutual exchanges are competing for the total transferable volume $2k$ of their customers. Which equilibrium will result and what will be the critical investment cost threshold? Each exchange will decide to invest at time period 0 if it expects its own

[15]The bank run literature presumes a similar investment pattern, for instance in the seminal paper of Diamond and Dybvig (1983). Hence it comes at no surprise that coordination failure and multiple equilibria build the core aspect of these models. As we will see later on, this will also be an important issue in the model presented here.

customers to leave volume k on its platform in period 1. This will be the case, if a member/user of an exchange has no incentive to reallocate its volume. Hence, the following condition must be satisfied:

$$\hat{a}(v+k) \leq cv + \underline{a}k \tag{3}$$

with $\underline{a} \equiv c - (\theta - \frac{I}{v+2k})$ defined as the trading costs if one of the exchanges manages to attract the transferable growth volume of both exchange users. On the left hand side, we have the trading costs for a customer when it sticks to its exchange, while the right hand side displays the average trading costs when it transfers its volume to the exchange, where $2k$ is traded. Inserting for $\hat{a}$ and $\underline{a}$ from (2) and (3), we get the following condition:

$$I \leq \frac{\theta v(v+2k)}{v+k}. \tag{4}$$

Let us denote I_m as the investment cost threshold of a mutual that competes against another mutual, defined as the costs where condition (4) is satisfied with equality. We can see from condition (4) that the growth trading volume k has a positive impact on the users' loyalty to their original exchange. The higher k, the more likely condition (4) is fulfilled so that it is in the interest of customers not to shift their trading volume. Intuitively c.p. a higher k means that the investment project generates a higher net present value for the users. Given our fixed investment costs I and the fact that the investment of the "home"-exchange also has a positive impact on the non-transferable trading volume v, a high net present value of the investment will induce each individual user to prefer its own exchange to invest. In contrast, investments, which have just a marginally positive net present value, will be undertaken by only one exchange, albeit it is not clear which exchange will be the investing one in such a symmetric case. However, introducing a small commonly known productivity difference between the exchanges into the model would favor the more productive exchange to invest, if it is common knowledge that the users can coordinate on the Pareto-dominant action. For now, we assume this to be the case, however we will discuss the issue of equilibrium selection in more detail at a later stage (see also the analysis in Appendix B).

Competition between a mutual and an outsider-owned exchange Let us now analyze the situation when a mutual exchange faces competition from a for-profit, outsider-owned exchange. For notational convenience, we assume that X_1 is organized as a mutual and X_2 as a for-profit exchange controlled by outside investors. Given our assumption on the varying degrees of commitment between the two organizational forms, the outsider-owned exchange does not need to be concerned with the risk to lose k of its own users to X_1. As we will show later, this will always be the case in equilibrium as long as the outsider-owned stock exchange invests. We will therefore start with the assumption that X_2 always obtains the loyalty of its users.[16] Given that X_2 invests, what are the alternatives for the mutual exchange?

[16]To support this equilibrium, one only needs the out-of equilibrium beliefs that the outsider-owned exchange would offer favorable terms to users who want to depart to the mutual exchange.

Let us first suppose that the mutual declares not to invest in time period 0. In this case, the members of X_1 will transfer k to X_2, as the latter will offer a trading fee that is at least as low as at X_1, i.e. c. Since X_2 maximizes its profits, it will just offer $a_2 = c$.[17]

Alternatively, both exchanges may announce to invest. Under the assumptions we made, the mutual exchange is most attractive when all its members stay loyal and trade the transferable volume k at their home-exchange, which would result in fees amounting to $\hat{a}$. However, they would transfer k to X_2 if and only if

$$a_2 k \leq \hat{a} k. \tag{5}$$

Accordingly, it is Pareto-dominant to remain loyal as long as $a_2 > \hat{a}$. However, in case of an equally good offer, the users of X_1 will switch. Hence, X_2 will attract the new volume if it offers

$$a_2 \leq \hat{a} \equiv c - (\theta - \frac{I}{v+k}). \tag{6}$$

Note that it is indeed profitable for X_2 to make such an offer, since it can potentially serve the customers at marginal cost $c - \theta$ and can gain revenues from this offer which are strictly higher than the marginal costs according to condition (6).[18]

Interestingly, even though the mutual exchange is in a disadvantage to retain the volume of its own members, let alone to attract new customers, we may still observe that it invests in the project. The rationale for this is that the *terms* of X_2's offer for the members of X_1 can be influenced to their advantage due to the positive strategic effect that emerges when X_1 also invests: Knowing that X_2 will invest, the members of X_1 anticipate the offer at transaction costs c in case X_1 does not invest. Therefore, members of X_1 could consider to take the investment at their own exchange and still divert their trading volume k to X_2. By doing so, the members of X_1 may force exchange X_2 to improve trading conditions from c to $c - \theta$.

To see this, consider the alternatives of the members of X_1: They will compare the costs of not investing with those of investing, provided that they will divert

[17] We assume that in case of an equally attractive offer, the original users of an exchange are curious and do not stay loyal to their home-exchange. Thus, X_2 merely has to offer conditions that are at least as good as their home exchange for attracting their new customers. This convention, which is without loss of generality, will be adopted to solve the "openness problem" common to Bertrand games.

[18] Furthermore, even if the investment project of the outsider-owned exchange is not as productive as the investment project of the mutual exchange, the former exchange will succeed in getting the growth volume of all users as long as the difference in productivity is not too large. To see this, let us assume that the investment costs of the projects I_i for both exchanges are equal, $I_1 = I_2 = I$, but the return of the investment θ_i is larger for the mutual exchange, i.e. $\theta_1 > \theta_2$. Inserting $a_2 = c - \theta_2$ and $\hat{a} = \hat{a}_1 = c - \theta_1$ in condition (6) for a success of the outsider-owned stock exchange, we observe that

$$c - \theta_2 \leq c - \theta_1 + \frac{I}{v+k} \Leftrightarrow \theta_1 - \theta_2 \leq \frac{I}{v+k}.$$

Again, the lower θ the more easily will this condition be satisfied. Technologically inferior investments by an outsider-owned exchange will be undertaken in competition with an mutual exchange because of a stealing effect that gains momentum due to the differences in the competitors' underlying organizational forms.

k in any case. Hence, the costs will be $cv + a_2k$ in the case of not investing. As already mentioned, X_2 does not have to make an offer a_2 below c so that the second summand will be equal to ck. In the case of investing, the costs would amount to $cv + I - v\theta + \hat{a}k$. Note that according to our assumption on the profitability of the investment project, I is always larger than $v\theta$. Hence, if

$$cv + ck \geq cv + I - v\theta + \hat{a}k, \tag{7}$$

which after inserting for $\hat{a}$ and collecting terms can be written as the investment condition

$$I \leq \frac{\theta(v+k)^2}{v+2k}, \tag{8}$$

the mutual exchange will invest, notwithstanding that it only serves the base volume v. I_{oo} denotes the investment cost threshold where this condition is satisfied with equality in the case when a mutual competes against an outsider-owned exchange. Taking the derivative of condition (8) with respect to k, one can see that, in equilibrium, the mutual exchange invests, if k is relatively large compared to v, i.e. if the competitive pressure is high, given our measure k/v. Hence, it is in the interest of X_1-members to invest when the size of the transferable volume is large. In such a case, they benefit from the better cost structure of the investing mutual exchange, since this will improve the conditions to which they can trade k on X_2. Notice the similarity of this argument to strategic models of "second-sourcing" in the tradition of Farrell and Gallini (1987) and Shepard (1987) who show that second-sourcing can be interpreted as a commitment device to protect buyers' interests against a monopolistic supplier's ex post opportunistic behavior. In our Bertrand competition model, the mutual exchange - working in the interest of its members - fulfills quite a similar role.

Comparison of investment propensities We have seen that due to the possibility to credibly commit to a certain fee level, for-profit exchanges will always invest in the efficiency-enhancing project. In fact, as the outsider-owned exchange always succeeds to attract the transferable volume of the mutual exchange k in equilibrium, it knows that its total trading volume is not only $v + k$ but adds up to $v + 2k$. Therefore the gross surplus resulting from the additional volume amounts to $k\theta$. As we have shown in the last section, a part of this rent has to be given to the new users because of the second-sourcing effect. However, the remaining part can be appropriated by the outsider-owned exchange, and this, in turn, will strengthens its investment incentives further. Hence, its investment boundary I_{FP} is

$$\theta(v+k) \leq I_{FP} \leq \theta(v+2k). \tag{9}$$

The mutual, on the other hand, lacks this characteristic and will therefore invest less heavily. What we still have to provide an answer for, though, is how the investment propensity of mutuals depends on the governance regime that the competing exchange possesses.

To see whether an exchange, organized as mutual, has a *higher* propensity to invest when it faces competition by an outsider-owned platform or by another mutual exchange, we compare the respective investment hurdle rates of X_1. Therefore, if we presume that I_{oo} is greater or equal to I_m, and replace the investment boundaries by the respective right hand sights of conditions (8) and (4), we obtain the following inequality:

$$\frac{\theta v(v+2k)}{v+k} \geq \frac{\theta (v+k)^2}{v+2k}. \tag{10}$$

Simplifying (10), we obtain the result that as long as

$$\frac{k^2}{v^2} - \frac{k}{v} \leq 1, \tag{11}$$

i.e. the level of competition expressed as $\frac{k^2}{v^2} - \frac{k}{v}$ is less or equal to one, the investment cost threshold, and propensity by same token, of a mutual will be larger, when competing against another mutual exchange. This holds as long as k is not significantly larger than v.[19] For transferable volumes significantly larger than the invariable amount, on the other hand, a mutual will have a higher propensity to invest when facing competition from an outsider-owned exchange. Therefore, if the degree of competition is very high among trading platforms, a mutual is more inclined to invest into efficiency-boosting modernization projects, if the competing counterpart is organized as a for-profit exchange. The reason for this bases on the dual-sourcing argument outlined earlier, which makes investments more likely, but which are only relevant when competing against a rent-seeking outsider-owned exchange.

Note that we so far considered situations, where the for-profit exchange treats all potential new customers from X_1 equally in the sense that the announced transaction costs are non-discriminatory for different customers or customer groups. However, in principle, exchange X_2 could make discriminatory offers to the members of the mutual exchange, if this proves to be profitable. As we analyze in appendix A, this divide-and-conquer strategy leads to a *snowballing* effect at the mutual exchange, resulting in a shift of the transferable volume k to the outsider-owned exchange. Therefore, while this result is skewed in favor of outsider-owned exchanges, the introduction of discriminatory offers also liberates our analysis from the assumption of the Pareto-dominance criterion, since the divide-and-conquer strategy deters coordination by the members of the mutual exchange. For our basic model, however, we will alleviate this strong assumption by analyzing our setup in a global games framework in the following.

Multiplicity of equilibria So far, by adopting the Pareto-dominance criterion we have assumed that the members of the mutual exchange can coordinate on an equilibrium to the best of their *common* interest. Naturally, this is not the only possible equilibrium. As usual in coordination games like ours, multiple Nash equilibria are possible. Thus, we will analyze whether we can get rid of the multiplicity of equilibria and specify precisely the parameter values of the model for which mem-

[19] In fact, the result holds as long as k is smaller than approximately 1.6 times v. Confer also section 2.2.3.

bers choose to move their transferable volume to the outsider-owned exchange. This would allow us to provide a comparative statics analysis of the factors that influence this decision, without imposing somewhat arbitrary assumptions regarding the behavior of the members.

To deal with this issue, we draw on the *global games* approach to find a unique equilibrium.[20] This approach builds on the idea that individual players, in our case the members of the exchange, are facing payoff uncertainty, which is caused by an underlying state of the economy. In our framework, this would correspond to uncertainty regarding the productivity parameter of the investment technology θ. Introducing this type of payoff uncertainty into the analysis, it can be shown that members, behaving individually optimal, will not be able to coordinate their actions on the Pareto-dominant equilibrium. Instead, in dependence of the underlying state, a unique equilibrium will always result. Typically, the resulting equilibrium will be the *risk-dominant* one, using the terminology of Harsanyi-Selten.

However, this equilibrium always implies some coordination failure among the members.[21] In our framework, the risk-dominant equilibrium corresponds to the outsider-owned exchange X_2 setting an offer $\check{a}$, with $a_2 < \check{a} < \hat{a}$, such that the trading costs are slightly lower than

$$\check{a} \equiv c - (\theta - \frac{I}{v + \frac{k}{2}}). \tag{12}$$

The condition shows that, because of the coordination problems of the members, the outsider-owned exchange will attract the members of the mutual exchange quite easily, even if it cannot use discriminatory offers, which we outlined in detail in appendix A.[22] Hence, coordination problems on part of the mutual's members reinforce the competitive edge of the outsider-owned exchange. We provide a detailed analysis in appendix B.

Summarizing the analysis of this section so far, we formulate the following proposition:

Proposition 1 *With homogeneous users we obtain the following results:*

1. *In a competitive environment with two mutual exchanges, both will invest, provided condition (4) is satisfied. For increasing values of k the condition is more likely to be fulfilled. In case of an investment project with only marginally positive value, only one exchange will invest.*

2. *In a competitive environment with one mutual exchange and one outsider-owned exchange, the latter has a competitive edge and a higher propensity to*

[20] See Carlsson and van Damme (1993) for a first illustration of this theory and Morris and Shin (2003) for a recent survey and full analysis of global games. The illustration chosen in appendix B follows closely Allen and Morris (2001) and Myatt, Shin, and Wallace (2002).

[21] Not only the global games literature is in support of the risk dominance criterion. Also the evolutionary stochastic adjustment dynamics literature, typified for example by Young (1993), provides independent theoretical justification for the selection of risk-dominant equilibria.

[22] Interestingly, the offer generates approximately the same profit for the outsider-owned exchange as the optimal offer structure when employing a divide-and-conquer strategy (see equation (34)).

invest, even if its investment project is somewhat less efficient. However, under certain conditions, the mutual exchange will invest in the new project, even though it will not retain k on its platform in order to improve its members' bargaining position vis-à-vis the outsider-owned exchange.

3. *The competitive advantage of the outsider-owned exchange over the mutual exchange increases if the outsider-owned exchange uses discriminatory offers. Additionally, the competitive advantage is higher when the members of the exchange cannot coordinate their actions.*

2.2.2 Competition between stock exchanges with heterogeneous users

One important assumption of our analysis so far was that all users are homogeneous. However, some investment projects of stock exchanges may have a diverse impact on their users. If one thinks about investments in non-core business activities such as derivative trading, post-trading activities and software sales, it is plausible to assume that these activities will afflict stock exchange user groups, i.e. brokers, broker-dealers, investment banks and commercial banks, in different ways. Thus, we incorporate heterogeneity into the model to analyze these kinds of investments. We will do so in a very simple and stark way by postulating that the investment decision has a heterogeneous influence on the gross surplus θ which different users of the exchange can extract. We thereby shortcut many interesting dimensions of these projects, which may also influence the investment decision.

However, in line with the description of investment projects we are considering, one should interpret θ as an externality exercised on the businesses of the users by the exchange's investment decision. We will assume that authority matters in the sense that the investment decisions will be taken by the majority of owners of the exchange. Furthermore, each individual θ_j is *private* information of user group j, however, the distribution of θ is common knowledge.[23]

In the following we focus on the interaction between a mutual exchange X_1 and an outsider-owned exchange X_2. To present the argument in the most simple form, we assume that even though the investment is profitable, i.e. $vE[\theta] < I < (v+k)E[\theta]$ holds, the surplus θ merely stems from a fraction of users y_h such that

$$E[\theta] = y_h \times \theta_h \equiv \theta. \tag{13}$$

Hence, a fraction y_h of users experiences a positive impact by the investment project, θ_h, while a fraction $1 - y_h$ has no positive influence, $\theta_{1-h} = 0$. To incorporate the flavor of the one-member, one-vote structure that is prevalent at mutual exchanges,

[23] More precisely, in line with the arguments made in Hart and Moore (1998) we are assuming that a firm, which is defined by its non-human assets, has to assign the authority for decisions on the use of assets and investments via its ownership structure, if a comprehensive contract cannot be written ex ante. Hence, in a mutual the decision power rests with the members according to the one-member, one-vote rule. In contrast, in an outsider-owned exchange the investors, which are solely interested in the profitability of projects, possess the control rights and can therefore be considered as homogeneous according to our understanding. Since we assume the surplus from the investment θ_j to be private information, ex post inefficiencies of the investment decisions are possible. It is an open question whether sophisticated mechanisms are possible to recontract these decisions. We assume here, also in line with Hart and Moore (1998), that this is not possible.

we assume that the decision rule regarding the investment project is a simple majority rule. Thus, in case of $y_h \geq 0.5$, the members with a positive impact will take the decision regarding the investment project, whereas it will be rejected for $y_h < 0.5$, as a majority of members would not benefit from the project, but would have to bear its costs. Let us presume that the outsider-owned exchange will invest. We will see later on that, in equilibrium, this will always be the case. Which decision will be taken by the mutual exchange?

In case the fraction y_h of members has a majority in the mutual exchange, the outsider-owned exchange attracts these members, if its offer is

$$a_2 \leq a_h \equiv c - (\theta_h - \frac{I}{v+k}). \tag{14}$$

Note that a_h differs from condition (6) by the term $\theta_h > \theta$, since the outsider-owned exchange has to make an offer, which matches the unit costs that the members with a strong positive impact can expect, given that the mutual invests. And in fact the mutual exchange, acting in the interest of its members with a positive impact, has a high incentive to invest, because only in this case, they benefit from the "second-sourcing" effect. The mutual exchange will thus invest, if it influences its members' rents positively, i.e. if

$$c(v+k) \geq (c + \frac{I - v\theta_h}{v})v + a_h k. \tag{15}$$

The condition for exchange X_1 to invest is hence

$$I \leq I_{ooHet} = \frac{\theta_h (v+k)^2}{v+2k}. \tag{16}$$

Therefore, since we have $I_{ooHet} > I_{oo}$, even relatively high investment costs do not deter the mutual exchange from investing in such a constellation. The investment costs will be borne in part by the $(1-y_h)$-fraction of members who are not positively affected by the investment, an effect which increases the investment incentives of the y_h-fraction of members. On the other hand, the members with no positive direct impact from the investment also profit from the offer a_h made by the outsider-owned exchange, since the outsider-owned exchange cannot distinguish between different member types. By offering a_h to all members for their volume k, it provides in fact a subsidy to the $(1-y_h)$-members. However, the outsider-owned exchange will still find it profitable to make the offer and invest into the project, since it can serve the additional volume k at marginal costs $c - \theta$. Thus, in equilibrium, the outsider-owned exchange will invest. And again, as already discussed for the case with homogeneous users, the investment propensity of the outsider-owned exchange is always higher than that of the mutual exchange, as the former attracts the users of the latter one.

What happens, when the members with $\theta_{1-h} = 0$ possess the majority? In that case, the mutual exchange will not invest, since the members in charge do not benefit from the investment. The outsider-owned exchange merely has to offer

$a_2 \leq c$ to attract the y_h-customers with the positive impact.[24] Summarizing this section we formulate the following proposition:

Proposition 2 *With heterogeneous users we obtain the following results in a competitive environment with one mutual exchange and one outsider-owned exchange:*

1. *The mutual exchange will invest in the project if condition (16) is satisfied and members with high value of θ are in the majority. However, the outsider-owned exchange has always a higher investment propensity than the mutual exchange.*

2. *Price discriminating offers do not improve the competitive advantage of the outsider-owned exchange.*

3. *If the members with $\theta = 0$ are in the majority, the mutual exchange will never invest and the outsider-owned exchange has the highest propensity to invest, since it merely has to undercut a quite unfavorable offer by the mutual, which gives the outsider-owned exchange large profit opportunities.*

2.2.3 A graphical illustration

To conclude section 2.2 and thereby our analysis of the static case, we provide a graphical illustration of our results. Figure 3 depicts the investment propensity of exchanges with different governance regimes and competition scenarios. More specifically, for the parameter values $\theta = 1$, $v = 1$ and $\theta_h = 1.5 \times \theta$, we display how the threshold investment costs I (vertical axis) depend on the level of competition approximated by k/v (horizontal axis), for different organizational forms. The areas under the respective graphs represent the feasible regions where the exchanges will invest.

The benchmark case with the highest investment propensity over the whole range is represented by an outsider-owned, for-profit exchange, indicated by the shaded area between the two solid lines denoted as I_{FP}. The outsider-owned exchange will always invest in the project as long as it has a positive net present value, i.e. if the right hand side of inequality (1) holds. This is depicted by the line $I_{FPLowerBoundary}$. However, since, in equilibrium, the outsider-owned exchange attracts the transferable volume of all members, it can at least partly appropriate the surplus generated by this volume. In the extreme, i.e. if it acquires the whole rent, it reaches an upper boundary of investment costs $I_{FPUpperBoundary}$.

[24] When the outsider-owned exchange is allowed to use discriminatory offers, it can - as shown in appendix A - exploit the externalities between the users of the mutual exchange. However, the optimal divide-and-conquer policy is more difficult to implement and not as effective now due to the heterogeneity of the members and their privately observed information on θ_j. To see this, we need to change the framework slightly and assume that the $(1 - y_h)$-group of user experience a small ϵ-value from the investment project instead of a zero value. Now an outsider-owned exchange cannot use the offer structure depicted in equation (33) to implement a snowballing effect, since, literally speaking, the snowball created by the first offer might not be sufficient to unleash a full-scale avalanche. While the outsider-owned exchange cannot distinguish between users with a high and a low value of θ, it has to overcome the informational problems by its offer structure. We do not want to go into more detail, but generally one can expect that the average offer of the outsider-owned stock exchange $E[a_\theta]$ will be higher than the offer depicted in equation (34). The outsider-owned exchange hence has an informational disadvantage vis-à-vis the users it wants to lure to its platform, which makes the transaction more costly.

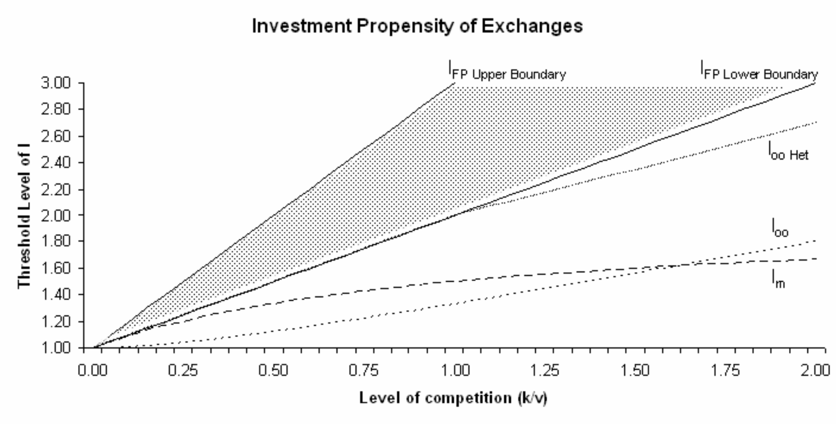

Figure 3: Thresholds for Different Governance Structures and Competition Levels

The graph I_m (dashed line) illustrates the case, where a mutual faces competition from another mutual entity. We see that the investment propensity rises quickly with the degree of competition, but levels off somewhat for higher k-to-v-ratios.

In contrast, a mutual exchange that competes against an outsider-owned exchange, denoted as I_{oo} (dotted line), initially has a lower investment propensity, but surpasses I_m for very high degrees of competition, i.e. for $k/v > 1.6$.

For mutuals that have heterogeneous members, with a majority possessing $\theta_h = 1.5 \times \theta$, the investment propensity will be as strong as at an outsider-owned exchange for low levels of competition (fine dotted line denoted as I_{ooHet}). The reason is the above mentioned second-sourcing effect in connection with the fact that part of the investment costs will be shared with those members that have no positive impact from the investment. For high levels of competition and high investment amounts, however, the costs of investing at the mutual exchange outweigh the second-sourcing effect and make an investment by the mutual unattractive. Consequently, the investment propensity will increase by a smaller pace than at the outsider-owned exchange.

Finally, if the majority of the members of the mutual exchange possess $\theta = 0$, i.e. they have no positive value from the investment, the exchange will not invest at all, which would correspond to a horizontal line at $I = 1$ in the figure.

2.3 The dynamic model - Viability of organizational forms

The framework we used in the last sections was a one-shot game, which is useful to analyze investment incentives in case of competition between different organizational forms. In the following, we want to focus on dynamic competition effects in order to analyze the viability of the respective governance regimes, in particular that of mutuals.[25] We will demonstrate that under certain conditions, an incumbent mutual exchange cannot survive, if an outsider-owned exchange enters its market. We will also see that an incumbent outsider-owned exchange will survive against an-

[25] In this section we borrow heavily from Rey and Tirole (2001).

other outsider-owned exchange on the other hand. These results imply that mutual exchanges that face competition from outsider-owned exchanges can only survive by changing their organizational form. Thus, our model provides a theoretical intuition for the ongoing demutualization wave in the stock exchange industry.

To model this, we consider an overlapping generations framework with discrete time periods and an infinite time horizon, i.e. $t = 0, 1, 2, \ldots, n$. Users of an exchange live for two periods in which they want to trade and in each period a new generation with a large number of users is born. To simplify the exposition, we assume that each generation has a mass of 1. Thus, at each period a "new" and an "old" generation exists, implying a continuum of agents of mass 2 at each date.

We denote the trading volume generated by the old generation at a certain time period as v and normalize it to $v = 1$, whereas the new generation generates a volume of $k = 1$ at the same date. Because of the long time periods we have in mind, we additionally assume a discount factor per time period of $\delta < 1$. Hence, in essence we are analyzing a particular case of our basic setup in terms of volume. The young generation decides freely where to allocate its trading volume k, while the old generation, for reasons to be explained in the next paragraph, always sticks with its volume at the exchange it decided to go one period earlier, i.e. when it constituted the young generation.

At each time period $t - 1$, an identical investment opportunity with costs I arises for the stock exchange and generates a gross surplus of θ for its users at date t. The investment is, again in accordance with our basic setup, only beneficial if the young *and* the old generation participate. Using the notation of the last section, the investment condition in discounted value terms is

$$I < \delta(v + k)\theta \qquad \text{with } v, k = 1. \tag{17}$$

In the following we analyze two organizational forms: (1) An outsider-owned exchange that can charge an unconstrained trading fee of a_t^{oo} to its users in t to finance the investment that was initiated in $t - 1$. (2) A mutual exchange that charges no entry fees and has no redemption rights makes its members pay the same amount a_t^m in case of investment irrespective of the generation they belong to.[26] In addition, with the young and old generation members being potentially heterogeneous groups, we have to specify the generation that has the control rights in the mutual exchange. In an overlapping generations framework, a generation born in $t - 1$, but being in charge of the investment decision at date t, will have no incentive to invest into a new investment project at date t. This is due to the fact that the payoffs of this investment accrue at date $t + 1$, where this generation will not exist anymore. Since we consider a mutual without redemption rights, there is no means by which they could benefit from the investment. Hence, to prevent

[26] Hence, here we are considering a nondiscriminatory mutual in its purest form which is not allowed to use entry fees, seniority-based charges, or redemption rights for members or transferable property rights. Of course, this is not a realistic assumption. However, because of their governance structure mutuals typically do not have the same high discriminatory power as outsider-owned firms. Thus, just to clarify the argument, the analysis in this section should be understood as modeling these differences in its extreme form. In a future version of the paper, we want to conduct a more balanced analysis by analyzing mutuals with some discriminatory power.

a negative bias in the analysis against the mutual exchange, we presume that the investment decision rights will always be allocated to the young members.[27]

Investment behavior without competition Let us shortly discuss what happens in this framework if there is no competition between exchanges. An outsider-owned exchange would set a trading fee of

$$a_t^{oo} = \theta$$

in each period.[28] In this way, it extracts all the rents resulting from the investment project. Accordingly, the intertemporal profit of the outsider-owned exchange can be described as

$$\Pi^{oo} = \frac{\delta(v+k)\theta - I}{1-\delta}. \tag{18}$$

When comparing the profit function with investment condition (17), it is obvious that the investment will be undertaken as $\Pi^{oo} > 0$.

In contrast, a mutual exchange without discriminatory trading fees will have problems to get the investment process started. In fact, the first generation of members has to finance two consecutive investment projects at date 0 and date 1 via its trading fees, but only obtains returns from the first investment, which pays off at date 1. In this sense, the members of the second generation are free-riding on the first generation, since the mutual exchange is not allowed to charge different trading fees to users at a certain point of time. Let us consider this more formally. Given the investment process gets started, in the steady state, the trading fees at each date would be

$$(v+k)a_t^m = I \qquad \text{for } t > 0. \tag{19}$$

This will result in a net surplus V^m for each generation of members that is born *after* date 0, which amounts to

$$V_t^m = \theta_t + \delta\theta_{t+1} - \frac{I_t}{2} - \delta\frac{I_{t+1}}{2} = (1+\delta)(\theta - \frac{I}{2}) \qquad \text{for } t > 0 \tag{20}$$

since $\theta_t = \theta_{t+1} \equiv \theta$ and $I_t = I_{t+1} \equiv I$. To understand equation (20), note the following: At period t, a member of the new generation that is born in this period has to share the investment costs I_t with the old generation and enjoys the gross surplus θ_t stemming from the investment at date $t-1$. It also has to take into account that it will have to finance the investment costs of the next project at date $t+1$ with its trading fees in that period, which will be shared with the new generation, but also will enjoy the surplus θ_{t+1} from the investment project of date $t+1$ initiated at date t. Therefore, both components have to be discounted by the factor δ. Given our assumption on the investment project (17), this surplus

[27]To align such a decision process with the majority rule, we only have to assume that the population of young users grows by a constant rate of $\eta > 0$ from period to period. For notational convenience we skip this issue here.

[28]To simplify the exposition in this section, we define the trading fee here in relation to the surplus generated by the investment. Hence, the trading fees are the *net* surcharges which users of the exchange have to incur as a result of the investment.

is positive. Table 1 illustrates the overlapping generations (OLG) structure for an ongoing mutual exchange with $\theta_t(I_{t-1})$ denoting the surplus of an $t-1$-investment at date t.

$t = 1, 2, \ldots$	t	$t+1$	$t+2$	$t+3$
Generation t	$\theta_t(I_{t-1}), \frac{I_t}{2}$	$\theta_{t+1}(I_t), \frac{I_{t+1}}{2}$		
Generation t+1		$\theta_{t+1}(I_t), \frac{I_{t+1}}{2}$	$\theta_{t+2}(I_{t+1}), \frac{I_{t+2}}{2}$	
Generation t+2			$\theta_{t+2}(I_{t+1}), \frac{I_{t+2}}{2}$	$\theta_{t+3}(I_{t+2}), \frac{I_{t+3}}{2}$

Table 1: The OLG Structure

However, to analyze whether a mutual exchange invests in the first place, one has to consider that the first investment project will only get started if

$$V_0^m = \delta\theta - a_0^m - a_1^m = \delta(\theta - \frac{I}{2}) - I > 0, \tag{21}$$

which describes the fact that the first generation has to bear the investment costs of the first project at $t = 0$ alone, and share the costs of the second project at $t = 1$, from which it will not even benefit. Hence, the surplus from the investment project, θ, must be relatively high in order to get the investment project started. Inserting $v, k = 1$ and comparing (21) with (18), one can easily see that projects with a smaller surplus will be started only by an outsider-owned exchange. The reason for this is that a mutual exchange invests, if the surplus is higher than $\theta = \frac{I}{2} + \frac{I}{\delta}$, whereas the outsider-owned exchange already invests for a surplus higher than $\theta = \frac{I}{2}$. We conclude that even if a mutual exchange does not face competition by other exchanges, it has a lower propensity than an outsider-owned exchange of investing into projects, as long as it is not allowed to charge new members for investments made in the past. In effect, we have a *time horizon* problem in the sense that socially desirable investments might not be undertaken. Therefore, the analysis so far leads to similar results as stated in proposition 1 and 2.

Competition between two mutuals Competition in this framework will, similarly to our basic setup, center on the decision where the young generation will allocate its volume. For the old generation it makes no sense to switch to a new-entrant exchange, which still has to invest. The payoffs of this investment will accrue at a time where the old generation does not exist anymore. In the following, we assume, as in most parts of section 2.2.1, that the users can coordinate themselves to take the offer, which fits best their *common* interest, i.e. we apply the Pareto-dominance criterion. First, we want to analyze the case, where an existing mutual exchange, which has invested in the past, faces the threat of entry by a rival mutual exchange. As can be seen from condition (20), the surplus for each young generation from trading at the incumbent mutual exchange is $(1 + \delta)(\theta - \frac{I}{2})$. A rival mutual exchange m' could at best make an offer according to equation (21) of $V_0^{m'} = \delta(\theta - \frac{I}{2}) - I$, which is clearly less. Hence, a rival mutual exchange cannot succeed in taking over the market from the incumbent, if it has not invested in the new project beforehand and, naturally, if the investment projects of the two rival exchanges are similarly efficient. This result indicates that it is difficult for a newcomer mutual exchange to compete against an incumbent exchange, if the newcomer does not possess a project that is far better.

Competition between a mutual and an outsider-owned exchange The second case we want to analyze is the competition between an incumbent mutual exchange and a newly created outsider-owned exchange. The outsider-owned exchange knows that the mutual exchange will break down if the former can convince the new generation of users to trade on its exchange. In that case, the members would not retain their volume at the mutual exchange, and since the old members cannot profit from a new investment, they would decide not to invest, accordingly. Hence, X_2 will be successful in acquiring the new generation, whenever its best possible offer is better than that of X_1. Thus, if the profit of setting up a new outsider-owned exchange is higher than the surplus the young generation receives when trading its volume at the incumbent mutual exchange, i.e.

$$\Pi^{oo} = \frac{\delta(v+k)\theta - I}{1-\delta} > (1+\delta)(\theta - \frac{I}{2}), \tag{22}$$

X_2 can make an offer a^{oo*} to the young generation such that its payoff from trading at X_2 is at least as high as $(1+\delta)(\theta - \frac{I}{2})$. The young generation will trade at X_2, thereby generating a profit of $\Pi^{oo} - a^{oo*}$ for the exchange. Inserting $v, k = 1$ and rearranging gives us the following condition

$$4\delta\theta + 2\theta(\delta^2 - 1) - I(1+\delta^2) > 0, \tag{23}$$

which must be satisfied to defeat the incumbent mutual exchange's offer. A closer look at this condition shows that this will be more likely for higher values of θ and δ, and lower investment costs I. Then the rents, which can be expropriated from the young users, are large enough to enable X_2 to take over the market. Using the same line of argument, it is obvious that an entrant organized as mutual cannot defeat an incumbent outsider-owned exchange. The outsider-owned exchange, maximizing the profits of its investors, always has the possibility to underbid the offer made by the mutual exchange. Thus, we can postulate that in competition with an investor-owned exchange the mutual exchange is fragile, even if it has an incumbency advantage.

Competition between two outsider-owned exchanges Finally, we analyze the case in which an incumbent outsider-owned exchange faces the competitive threat by another outsider-owned exchange. The incumbent stock exchange again benefits from the fact that it has already invested in the past period. This ensures the stability and viability of the exchange in future periods. However, the incumbent outsider-owned exchange is constrained in the level of fees it can charge to the new generation. The potential entrant could induce the young generation to join the organization, in fact forming a new for-profit exchange by its own. Such an exchange would secure its owners at least $-I + \delta\theta$, even if it is anticipated that both exchange will compete later on for the still unborn generation in a Bertrandfashion. Hence, if the investment project is so valuable that $\delta\theta > I$, the incumbent outsider-owned exchange cannot extract all the rents from its users. The better the investment technology of the potential rival exchange, the lower will be the profits of the incumbent exchange. We believe that exactly such a market environment describes today's situation in the stock exchange industry quite well. The stock exchanges face strong competition by users which, due to technological developments, can threat to, and actually do, form their own trading platforms.

Competition between a mutual and an outsider-owned exchange - revisited However, this competitive threat also has an interesting feedback-effect on the offer, which an entering outsider-owned stock exchange can make to the young generation of an incumbent mutual exchange. Anticipating that it will face strong competition of the type just described in later periods, the outsider-owned exchange can offer at best its surplus

$$\Pi^{oo} = \frac{\delta(v+k)\theta - \delta\theta}{1-\delta}, \tag{24}$$

which has to be higher than $(1+\delta)(\theta - \frac{I}{2})$ in order to acquire the young generation. Inserting and rearranging gives a new and stricter condition on the parameters of the investment project which have to be satisfied. Hence, the entering outsider-owned exchange will gain the young generation's volume only if:

$$\frac{\delta\theta}{2\theta - I} > \frac{1-\delta^2}{2}. \tag{25}$$

Therefore, the anticipation of competition in the future deters the outsider-owned exchange slightly from taking over the market from the mutual exchange. However, the comparative statics regarding the parameters of the investment project remain the same as stated above.

Heterogeneity of users Heterogeneity of users would presumably strengthen the effects we described in this section. As already discussed in section 2.2.2, the competitive edge of the outsider-owned exchange is fostered, while the stability of the mutual exchange suffers when the members are heterogenous and the members with a low θ are in the majority. Insofar, we can expect that the dynamics, which we were able to illustrate here, will be even more powerful in case of investment projects with heterogeneity. In line with our interpretation of such projects, we therefore should observe particularly investments into non-core activities in order to unravel the market dynamics we described. However, a formal analysis of the heterogeneous case will be conserved for a later version of the paper. Summarizing the discussion in this section leads to the following proposition:

Proposition 3 *Under the assumptions that each period provides an investment project, which is only profitable for the exchange's total per period business* $(v+k)$ *and which has a homogenous influence on users, we have the following results in an overlapping generations approach:*

1. *An incumbent mutual exchange cannot survive against an outsider-owned stock exchange when condition (25) holds.*

2. *In contrast, an incumbent outsider-owned exchange can never be defeated by a mutual exchange.*

3. *The threat of entry by other for-profit stock exchanges or trading platforms does not undermine the viability of an incumbent outsider-owned exchange. However, it limits the market power of the incumbent outsider-owned stock exchange and forces it to share some rents with the new users, thereby making the exchange less profitable.*

Considering these three cases together, a mutual exchange, facing competition from an outsider-owned exchange, can only survive if it demutualizes and becomes an outsider-owned entity itself.

3 Empirical evidence

3.1 Hypotheses

The main results of our theoretical model need to be tested empirically in order to verify their validity. In particular, we are interested whether exchanges are indeed more likely to demutualize when they are under competitive pressure and whether an outsider-owned governance structure increases the propensity to invest into related activities, which is the essence of our propositions derived in section 2. We will therefore focus on two hypotheses that can be tested by the data available to us. First, as in Ramos (2005), we test whether competitive pressure has an impact on the likelihood that exchanges demutualize. Thus our first hypothesis states:

H1: Competitive pressure will increase the likelihood of demutualization for exchanges.

Second, we want to verify our theoretical outcome that for-profit exchanges have a stronger tendency to invest into related business activities than mutual exchanges. Our findings in the model refer foremost to outsider-owned exchanges as the results are mainly driven by the fact that these exchanges can take investment decisions unconstrained of correlated business interests that their members have. Therefore, we state the following hypothesis on this subject:

H2: Outsider-owned exchanges are more likely to invest into post-trading, derivatives trading and IT-development activities than mutuals.

3.2 Methodology

As we will see in detail in section 3.3, we employ variables describing the related activities, the governance regimes, and the competitive environment of exchanges.

We will employ Probit regressions to test our hypotheses, since the data structure of our dependent variables, i.e. the governance and related activities variables, are all of dichotomous nature. One way to approach this issue is to estimate the effects of competitive pressure on the likelihood of demutualization and the effects that demutualization and competitive pressure have on the likelihood of investing into related business activities in two separate univariate Probit regressions. However, this creates a potential endogeneity problem as demutualization itself is explained by the competition variables and thus cannot assumed to be exogenously given, when we consider the investment activities of exchanges in related activities. As a result, it is more prudent to employ a bivariate Probit model as was proposed by Greene (1998) and Greene (2000, p.849-852) and estimate the investment decision and demutualization equations simultaneously.[29]

As we consider three distinct related areas in which exchanges can invest, we will estimate three simultaneous equation pairs. The first pair of equations calculates Probit regressions on the likelihood that the exchange invests into post-trading activities (SETTLE) and that the exchange is demutualized (DEMUT), respectively. For the remaining two pairs of equation systems, we substitute the dependent variable of the first equation with DERIV and SOFT in order to estimate the likelihood of an exchange being active in the derivatives and IT-services business, respectively. Therefore, the three regressions have the following form:

$$\begin{aligned} SETTLE &= \vec{\beta_1}'\vec{x_1} + \epsilon_1, \quad SETTLE = 1\ if\ SETTLE > 0,\ 0\ else \\ DEMUT &= \vec{\beta_2}'\vec{x_2} + \epsilon_2, \quad DEMUT = 1\ if\ DEMUT > 0,\ 0\ else \end{aligned} \tag{26}$$

$$\begin{aligned} DERIV &= \vec{\beta_1}'\vec{x_1} + \epsilon_1, \quad DERIV = 1\ if\ DERIV > 0,\ 0\ else \\ DEMUT &= \vec{\beta_2}'\vec{x_2} + \epsilon_2, \quad DEMUT = 1\ if\ DEMUT > 0,\ 0\ else \end{aligned} \tag{27}$$

$$\begin{aligned} SOFT &= \vec{\beta_1}'\vec{x_1} + \epsilon_1, \quad SOFT = 1\ if\ SOFT > 0,\ 0\ else \\ DEMUT &= \vec{\beta_2}'\vec{x_2} + \epsilon_2, \quad DEMUT = 1\ if\ DEMUT > 0,\ 0\ else \end{aligned} \tag{28}$$

$$\begin{aligned} E[\epsilon_1] &= E[\epsilon_2] = 0,\ respectively \\ Var[\epsilon_1] &= Var[\epsilon_2] = 1,\ respectively \\ Cov[\epsilon_1, \epsilon_2] &= \rho,\ respectively \end{aligned}$$

The maximum likelihood estimation is derived from the following equations with

[29] One drawback of this approach is that we cannot take into consideration our panel data structure as such a model is not provided by Stata 8. To alleviate this problem, we will adjust for within-cluster correlation of exchanges by using the cluster option. Additionally, we will separately estimate univariate random effects Probit regressions for robustness check purposes, as is outlined in Greene (2000, p.837-842) The results are provided in appendix E.

respective bivariate cumulative normal distributions Φ:

$$Pr[SETTLE = 1, DEMUT = 1|\vec{x_1}, \vec{x_2}] = \Phi(\vec{\beta_1}'\vec{x_1}, \vec{\beta_2}'\vec{x_2}, \rho) \tag{29}$$

$$Pr[DERIV = 1, DEMUT = 1|\vec{x_1}, \vec{x_2}] = \Phi(\vec{\beta_1}'\vec{x_1}, \vec{\beta_2}'\vec{x_2}, \rho) \tag{30}$$

$$Pr[SOFT = 1, DEMUT = 1|\vec{x_1}, \vec{x_2}] = \Phi(\vec{\beta_1}'\vec{x_1}, \vec{\beta_2}'\vec{x_2}, \rho) \tag{31}$$

Hence, the bivariate Probit model allows us to estimate the two equations simultaneously. In the spirit of the seemingly unrelated regression models, the disturbances may correlate and will be displayed by the parameter ρ.[30]

3.3 Data description

In equations (26) - (31) , vectors $\vec{x_1}$ and $\vec{x_2}$ are a (sub)set of independent variables with accompanying coefficients $\vec{\beta_1}$ and $\vec{\beta_2}$. To capture governance and competition, we employ the variables depicted in table 2. The first column provides the names of the employed variables, while the second column offers a brief description. The third column specifies in which form these variables are used in our regressions. Consider for example SETTLE, which is one of two dependent variables in our first simultaneous equations pair. For our independent variables, BOARDCOMP, for instance, is included in both $\vec{x_1}$ and $\vec{x_2}$, whereas LISTED, indicating exchanges with outsider-ownership, is only part of vector $\vec{x_1}$. As the purpose of the second equation and vector $\vec{x_2}$ is to estimate the determinants that affect the likelihood of demutualization, it makes no sense to include a state of governance that cannot exist *prior* to the restructuring. Columns four and five provide the mean and standard deviation of our variables, respectively.

In the following, we will describe the variables that we hand-collected for that purpose in more detail. While some of our variables are straightforward, the employed variables to capture the notion of competitive pressure require a lengthier discussion as it is rather fuzzy in its specification.

We acquired annual descriptive data on 50 stock exchanges, which are considered to be the main equity trading entities in the world according to the World Federation of Exchanges (FIBV), from the HP Handbook of World Stock, Derivatives & Commodity Exchanges 1999-2004 and the annual trading statistics reports of the FIBV. Additionally, we gathered information from stock exchange annual reports, web sites and by direct mail correspondence with exchanges.

We collected country-specific data from three sources: (1) Information on trading costs for 42 countries, which we were able to collect from the *Institutional Investor* that provided the figures calculated by Elkins/McSherry.[31] (2) To capture the economic openness of a country's capital markets, we used the 'Capital Market

[30] In a univariate Probit model, in contrast, the implicit assumption is that $\rho = 0$.

[31] We obtained the data for the years 1996-1999 and 2001-2004. For the year 2000, unfortunately we were not able to get the data and therefore had to interpolate them.

Variable	Description	in Regression	Mean	SD
$SETTLE_{i,t}$	Dummy for exchange i possessing post-trading in t	Dep. Variable	0.438	0.50
$DERIV_{i,t}$	Dummy for exchange i possessing derivatives trading in t	Dep. Variable	0.2	0.40
$SOFT_{i,t}$	Dummy for exchange i possessing software sales in t	Dep. Variable	0.623	0.49
$DEMUT_{i,t}$	Dummy for exchange i if demutualized in t	Dep. Variable	0.508	0.50
$LISTED_{i,t}$	Dummy for exchange i if publicly listed in t	$\vec{x}_1$	0.254	0.44
$BOARDCOMP_{i,t}$	Composition of board of directors of exchange i in t calculated as representation of different stakeholder groups by directors (sum of squared fractions of broker, issuer, investor, state and other representatives)	$\vec{x}_1$,$\vec{x}_2$	0.565	0.22
$\Delta TRADEREV_{i,t}$	Change in revenues per traded share from Cash market operations of exchange i from t to t+1	$\vec{x}_1$,$\vec{x}_2$	-0.08	0.37
$CMCONTROL_{i,t}$	Index for openness of capital markets provided Fraser Institute in home country of exchange i in t	$\vec{x}_1$,$\vec{x}_2$	7.293	1.89
$TRADECOST_{i,t}$	Elkins/McSherry trading costs (commissions and fees only) in home country of exchange i in t	$\vec{x}_1$,$\vec{x}_2$	33.27	16.3
$SIZE_{i,t}$	Log value of equity shares traded (PPP-adjusted) at exchange i in t	$\vec{x}_1$,$\vec{x}_2$	12.36	1.99

Table 2: Data Description

Controls' measure of the Fraser Institute compiled by Gwartney and Lawson (2005). (3) We used exchange rate and purchasing power parity data from the World Bank 'World Development Indicators' for currency conversion purposes.

Depending on the data requirements of our respective empirical analyses, we either considered the full sample of countries or only a subsample of it. The full sample was used to provide the descriptive 'event-studies' presented in section 1 and discussed in more detail in appendix F. Our regression analysis on the other hand demanded a richer data set, which reduced the sample size to 26 exchanges. The period under consideration is from 1999 until 2003, although for one variable (ΔTRADEREV) we also considered the change in data from 2003 to 2004.

To test the hypotheses advanced in section 3.1 empirically, we need variables that (1) capture different governance regimes, (2) related business areas that stock exchanges could potentially invest in, and (3) the notion of competitive pressure. In the following, we will discuss these variables in more detail.

Related business activities We will employ variables capturing related business activities for hypothesis H2. To that end, we identified the provision of derivatives trading, post-trading services and IT services as the main activities that are related to the traditional cash market operations of stock exchanges. We assigned the following dummy variables: (1) If an exchange reported derivatives trading volume to the FIBV and/or reported revenues from this activity in its annual reports and/or stated a majority stake in a derivatives platform in its annual reports, we assigned $DERIV$=1, and $DERIV$=0 otherwise. (2) An exchange was assumed to provide post-trading services, if it either reported these revenues separately and/or stated a majority stake in a settlement institution in its annual reports. We then assigned $SETTLE$=1, and $SETTLE$=0 otherwise. (3) Finally, exchanges that reported revenues from IT-service activities were assigned $SOFT$=1, and $SOFT$=0 otherwise.

Governance regime We need governance variables for both stated hypotheses. For hypothesis H1, we need a dependent variable that indicates whether an exchange has converted towards a demutualized entity. For hypothesis H2, we will employ a governance variable as independent explanatory variable, capturing outsider ownership in the exchange.

We distinguish between the following three different governance regimes: We define an exchange as (1) mutual, if the entity has not announced demutualization and operates on a one-member, one-vote basis or is controlled by the state. An exchange is considered as (2) demutualized, if the exchange announced demutualization, but has not sought a public listing yet. And an exchange is considered to possess a (3) demutualized, outsider-dominated structure, if it is publicly listed.

To operationalize the distinctions, we define two dummy variables. The variables can take the following configurations: (1) A mutual exchange, denoted as $DEMUT = 0 \wedge LISTED = 0$, i.e. neither demutualized nor listed. (2) A demutualized exchange, denoted as $DEMUT = 1 \wedge LISTED = 0$, i.e. demutualized but not listed. (3) A publicly listed exchange, denoted as $DEMUT = 1 \wedge LISTED = 1$, i.e. both demutualized and listed.[32]

Competition In our regressions, we are interested whether competition affects the behavior of exchanges to demutualize (Hypothesis H1). Additionally, when we estimate the impact of outsider ownership on investment decisions at stock exchanges, our regression models will also employ competition variables as control variables (Hypothesis H2).

Specifying competition in the stock exchange industry is relatively straightforward in theory and there is a significant body of literature that devoted to different aspects of competition in this area.[33] However, most empirical attempts to measure competition focus on one or few exchanges and normally use bid-ask spread information.[34] Large-scale international comparisons on the level of competition at stock exchanges are much rarer due to the demanding data requirements.

Alternative methods used by industrial economists to quantify competition seem to be difficult to implement in this industry. Take for example the widely used Herfindahl-index, which infers information on the competitive environment by calculating a concentration measure within an industry. Such an approach is not directly applicable here for at least two reasons: (1) On a country level, the number of sizable competitors is limited. In many countries the exchange industry has already consolidated, resulting in one major national stock exchange that serves the lion's share of transactions.[35] A noticeable domestic threat to the incumbent

[32]Note that the configuration $DEMUT = 0 \wedge LISTED = 1$ does not exist, since all listed exchanges underwent a demutualization process before.

[33]Ramos (2003) provides a comprehensive survey on the literature concerned with competition in the stock exchange industry.

[34]Several examples are provided in the survey of Ramos (2003).

[35]The exception represents the situation in the US, where Nasdaq and NYSE process both

exchanges may arise from alternative electronic trading venues and from large financial institutions that match customer buy and sell orders internally. Thus, if we had data on these trading volumes, such a concentration measure would be meaningful. However, to our knowledge, there is no database that is both consistent and comprehensive enough to meet our cross-sectional and longitudinal requirements. (2) Instead of measuring concentration within a national market, one could create supranational regions or even one 'world region'. However, besides the fact that the selection of regions would be highly subjective due to the lack of a clear distinguishing criterion, such an approach would also ignore the still persisting regulatory constraints for effective cross-country competition and home bias in equities trading.[36] Hence, it would be misleading to assume that stock exchanges are competing directly against each other on a (global) level playing field, as such a setting would strongly depend on the openness of the financial market to potential competitors. By the same token, we believe that for most countries in our sample, competitive pressure is more likely to be exerted by other domestic players, be they competing regional exchanges, electronic trading platforms or the exchanges' own customers. Therefore, a concentration measure on the national level would be more desirable in principle.

A further method is the use of the H-statistics by Panzar and Rosse (1987) in order to derive revenue elasticities for each exchange, providing a crude indicator whether the considered entity operates under perfect competition, monopolistic competition, or no competition. The method has great appeal insofar as it seeks to measure the impact of competition directly at the exchange. Andersen (2003) uses this approach and provides a measure for exchange-specific level of competition. One drawback is that the method demands a comprehensive breakdown of the cost and revenues, which we do not possess for all exchanges in our sample. Furthermore, it assumes that the firm objective is to maximize its profits, a condition that cannot be maintained for the mutual exchanges in our sample.

Another, more general point of concern when measuring competitive pressure is that exchanges are engaged in several activities that can experience different degrees of competitive pressure. For our purposes, it makes sense to focus on competition in the cash market operations for at least two reasons: (1) Cash operations represent the set of activity, which is provided by every stock exchange in our sample, whereas other - related - activities are only offered by some of them. Thus, in order to ensure comparability of our competition variables, we should concede ourselves to this activity. (2) Cash trading is what stock exchanges have been created for, initially. Thus, if we believe that competitive pressure had an impact on the decision of some stock exchanges to restructure their governance regime, we would conclude that the main driver for such a move should be strongly correlated with an ex-

significant volumes in US equities. Also, in some countries such as Germany, regional exchanges still exist, but the trading volumes are insignificant compared to those of the main incumbent.

[36] In countries such as Italy, Spain and France, the national exchange still enjoys considerable regulatory protection by the so-called concentration rule, which serves as a barrier against entrants. However, with the implementation of a new regulatory framework for the European securities industry (MiFID) in 2007, the European Commission strives to create a more level playing field within the EU.

changes' perception of how threatened this core activity is. In any case, even when we merely focus on the cash market operations, we are confronted with several distinct activities such as issuer services, trading services, the dissemination of market information and regulatory functions that may all be influenced differently by the underlying economical characteristics and the regulatory framework of the industry. Although the competitive pressure felt in these activities may be correlated to some extent, it becomes clear that measuring competition in this industry is far from being one-dimensional. As a result, we seek to shed light to this issue from multiple angles in order to achieve a comprehensive picture of the level of competition that an exchange experiences. In total, we will employ five competition variables in our regressions, which we discuss in the following:

(1) BOARDCOMP: One way to approach competitive pressure is to infer information from the relative bargaining power of different stakeholders of the exchange, particularly that of banks and brokers. The intuition is that - provided that exchanges were initially established by intermediaries - this group also had the control over the entity, which should be observable in their representation in the board of directors. Now, consider a situation where, due to more outside options for other stakeholder groups, such as issuers and investors, their bargaining power declines vis-à-vis these other groups. This may happen when new trading venues offer their services to issuers and investors. As a consequence, it seems likely that banks and brokers would be willing to grant a greater say to these customer groups by offering seats on the exchange's board. Thus an increased diversity of representation could be interpreted as a loss in bargaining power by the incumbent intermediaries, which should be the result of increased competitive pressure on the exchange and therefore could be the precursor to demutualization.

To this end, we assessed the board's degree of homogeneity. In a first step we distinguished between five stakeholder groups, namely intermediaries, issuers, investors, state and other, and counted the number of non-executive board directors that represent these groups. In a second step, we divided each groups' number of representatives by the total number of directors, squared the results and summed them up. As a result, our measure can reach a minimum value of 0.2 for a completely uniform distribution of representation among the five stakeholder groups and a maximum value of 1.0 for boards that are completely dominated by one group, which is usually the group of banks and brokers.[37] For our sample of 26 exchanges, we were able to calculate the variable in all years except for Euronext and Singapore in 1999. Here, we assumed a similar representation in the boards as in 2000, respectively. For our regressions, we ex ante assume that lower values of our measure will make a demutualization more likely. Thus, we expect a negative coefficient.

(2) ΔTRADEREV: This variable captures competition in a more direct way by

[37]Our intuition remains largely unaffected for countries were the exchange was founded by the state. In our sample, the exchanges of Istanbul, Kuala Lumpur and Thailand were wholly owned by the state in 2003 and state representatives make up the majority of directors in the board. Thus, for these exchanges, our measure is close to one and therefore points in the same direction as if the board was only represented by intermediaries. Since a state-owned exchange is usually not under fierce competitive pressure, the inference on competition should be unaffected by this control structure.

focusing on the fees charged to its customers. Since the fee structure at exchanges is often very complicated and subject to negotiation with the customers, the official trading fees are neither very meaningful nor comparable across exchanges. We therefore approach this issue by calculating the revenues the exchanges earned *per traded share* to approximate their true fee structure. Acknowledging the fact that exchanges will differ in the way they report their revenues for cash trading activities and which components of trading services are included in these figures, we realize that the absolute level of revenues per traded share is not very useful. However, the *change* of revenues per traded share may have a stronger explanatory power for competitive pressure. The intuition is simple: Exchanges will tend to lower their prices (i.e. the revenues per share) only if they actually have to do so, which should often coincide with increased competitive pressure.[38] For our sample of 26 exchanges, we thus calculated the annual log-changes in revenues per traded share. From this measure, we ex ante expect a negative coefficient as this implies that a decrease in revenues led to a higher likelihood of demutualization.

(3) CMCONTROL: The economic openness of an exchange's home capital market could provide an indication on the contestability of the financial services industry in general and the stock exchange industry in particular. Thus, if a capital market is more open, then its incumbent should be under stronger competitive pressure than an exchange operating in a very repressive capital markets environment. To operationalize this notion, we used the index of 'Capital Market Controls' provided by Fraser Institute for the home capital markets in our sample, which assigns index values ranging from 1 (repressive) to 10 (completely open).[39] According to the metrics of this index, we would expect a positive coefficient, as this would mean that higher openness leads to higher competition, which in turn leads to higher likelihood of demutualization.

(4) TRADECOST: The trading fees and commissions that investors have to bear when they trade varies significantly across exchanges. We presume that this should be somewhat inversely related with the degree of competition that exchanges are exposed to. This is due to the fact that exchanges that operate in a more competitive environment will be forced to keep trading fees and commissions lower ceteris paribus than at trading venues, where competitive pressure is absent. To proxy this notion, we obtained data from the *Institutional Investor* which presented the trading costs incurred by institutional investors and calculated by Elkins/McSherry for the years 1998-2004.[40] The reports break the costs down into an explicit component, which include fees and commissions for brokerage and exchange services, and into a cost component that is more implicit in nature, namely market-impact costs. Since the latter depends strongly on the depths of the underlying market

[38] This line of reasoning may be less appealing in the case of not-for-profit mutuals, which may also lower prices to increase the welfare of their members.

[39] We used the data from column '4E' of the Economic Freedom of the World 2005 Annual Report data base for the years 2000-2003. For the year 1999 in our sample, we employed the data from 1995 as this was the closest year in which this data was provided prior to 2000.

[40] By using this type of data we implicitly presume that the trading costs measured per country are equal to the costs for the respective national exchange, we included in our sample, which may not be completely the case for countries possessing additional (regional) exchanges.

and to a lesser extent on the degree of competition in this industry, we decided to consider only the explicit cost components of trading.[41] We expect that lower trading costs are the result of competitive pressure and will lead to higher likelihood of demutualization. We therefore presume a negative coefficient.

(5) SIZE: It is well documented in the economic literature on network industries that larger firms will possess a stronger bargaining power vis-à-vis its customers and will tend to resist competitive pressure more easily than smaller exchanges.[42] We therefore want to include a proxy for the size of an exchange. As we are primarily interested in describing the competitive position of the exchange in its traditional cash market, we opted for the log values of annual trading volume in equity shares at an exchanges in US dollars.[43] We expect this variable to possess a negative relation to the likelihood of changing the governance regime.

3.4 Empirical Results

Table 3 displays the results from the bivariate Probit regressions for n=130 observations, where the upper panel displays the results from our maximum likelihood estimates for the first equation (SETTLE, DERIV, SOFT) and the lower panel shows the estimates from the second equation (DEMUT), respectively. The respective Wald-χ^2-value for each of the three regressions in columns (2), (3) and (4) is large, signifying that the hypothesis that our estimated coefficients are zero can be rejected. The correlation term ρ suggests that the correlation for our SOFT-regression in column (3) seems to deviate substantially from zero. Furthermore, the Wald-test of ρ=0 provides weakly significant support on the 15%-level that the term is significantly different from zero. As a result, a separate estimation of the DEMUT and SOFT-regression should be treated with caution.[44]

Results for hypothesis H1 Hypothesis H1 stated that increased competitive pressure will increase the likelihood of demutualization. As can be seen in table 3, demutualization is significantly influenced by all of our competition variables, save for the ΔTRADEREV-variable.[45]

The results virtually do not vary across our three regressions in columns (2), (3)

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[41] Otherwise, exchanges with are larger liquidity pool could be potentially favored in our analysis vis-à-vis smaller exchanges merely on the grounds of possessing a deeper market. When comparing the portion of market impact costs as of total cost in the Elkins-McSherry data base for the top and bottom quartile of exchanges measured by value of shares traded in 2004, we however did not find large differences. They amount to 36% and 33%, respectively. As expected, incorporating market impact costs into our analysis therefore has no significant effect on our results.

[42] For economics of network industries see for example Economides (1996)

[43] We adjusted the figures by the purchasing power parity obtained from the data bases of the World Bank (World Development Indicators 1998-2004)

[44] We provide the results from estimating the equations separately in appendix E as a robustness check to our bivariate regressions. For that matter, we employed univariate Probit regressions with clustering and with random effects as well as a univariate Logit regression with random effects. However, we find no material changes in our estimates except for the DERIV-regressions, where the coefficients of the LISTED-variable is only significant in the Probit regression with clustering. Furthermore, the estimate of the DERIV-equation in the Logit random effects model does not bring useful results.

[45] However, at least the sign in all three regressions is as expected: A decrease in revenues per traded share led to a higher likelihood of demutualization.

	Bivariate Probit Regressions		
(1)	(2)	(3)	(4)
Related Business Activity:	**SETTLE**	**DERIV**	**SOFTWARE**
LISTED	**1.053****	**0.749***	**1.372****
Std. Err.	*0.462*	*0.397*	*0.603*
BOARDCOMP	**0.148**	**0.677**	**0.118**
Std. Err.	*0.843*	*0.936*	*0.998*
ΔTRADEREV	**0.417**	**-0.032**	**-0.469***
Std. Err.	*0.370*	*0.297*	*0.265*
CMCONTROL	**-0.283****	**-0.02**	**0.179**
Std. Err.	*0.126*	*0.136*	*0.219*
TRADECOST	**0.006**	**-0.056*****	**-0.035†**
Std. Err.	*0.012*	*0.014*	*0.022*
SIZE	**0.019**	**-0.377****	**0.006**
Std. Err.	0.102	0.162	0.123
CONST	**1.115**	**6.503*****	**-2.058**
Std. Err.	*1.919*	*2.406*	*2.809*
Demutualization:			
BOARDCOMP	**-2.681*****	**-2.554*****	**-2.684*****
Std. Err.	*0.940*	*0.897*	*0.957*
ΔTRADEREV	**-0.209**	**-0.188**	**-0.202**
Std. Err.	*0.439*	*0.443*	*0.433*
CMCONTROL	**0.298*****	**0.301*****	**0.301*****
Std. Err.	*0.115*	*0.114*	*0.113*
TRADECOST	**-0.024***	**-0.023***	**-0.023***
Std. Err.	*0.014*	*0.012*	*0.013*
SIZE	**-0.270*****	**-0.266*****	**-0.263*****
Std. Err.	*0.094*	*0.097*	*0.092*
CONST	**3.454***	**3.282***	**3.295***
Std. Err.	*1.833*	*1.783*	*1.769*
Observations	130	130	130
Wald $-\chi^2$	60.64	74.42	43.03
ρ	0.305	0.154	0.369
Wald test of $\rho = 0$ **:**			
χ^2**/Prob** $> \chi^2$	1.650/0.199	0.357/0.549	2.315/0.128

†, *, **, *, represent 15%, 10%, 5% and 1% levels, respectively.**

Table 3: Bivariate Probit Regressions Results

and (4). As expected, a less homogeneous board composition, i.e. when BOARDCOMP becomes smaller, significantly increases the likelihood of demutualization, which supports the notion that exchanges being under stronger competitive pressure (here expressed in terms of their bargaining power vis-à-vis other stakeholder groups) were more likely to demutualize. A similar picture provides our CMCONTROL-variable, where we observe a significant increase in the propensity to demutualize at exchanges that are based in countries with relatively open and thus more competitive capital markets. Our variable TRADECOST also significantly displays the expected negative sign, implying that lower trading costs for investors lead to a higher likelihood of demutualization. Finally, our SIZE-measure also produces the expected results, displaying a significantly negative relation between size of the exchange and its likelihood of demutualization.

In summary, our regressions strongly support our theoretically derived hypothesis H1 that competitive pressure influences the likelihood of demutualization.[46]

Results for hypothesis H2 Hypothesis H2 states that an outsider-owned governance structure will have a positive impact on the likelihood of investments into related activities.

[46] Our results are confirmed by the finding of Ramos (2005) who comes to similar conclusions in her univariate Probit regressions.

Our results confirm hypothesis H2 for all three related business activities, as the coefficient of the LISTED-variable is significantly positive in each case. However, the relationship seems to be weaker in the DERIV-case, where we see significance only on the 10%-level.

The impact of outsider-ownership on the propensity of exchanges to invest into related activities is quite clear. Each of the regressions indicates that outsider-owned exchanges are more active in this field. Interestingly, this observation is not as clear for investments into derivatives trading. Furthermore, our robustness checks with univariate Probit regressions largely do not confirm a significantly positive impact of outsider-ownership on the likelihood of possessing a derivatives trading platform. Therefore, customer-owned mutuals might be equally likely to invest in this field. Using the line of argument of our model, we would argue that this may be due to the higher proximity of the derivatives business with the customers' own (cash-trading) business compared with the other two considered activities. As a consequence, the potential rents may distributed more evenly across different types of members in this related activity.

4 Conclusion

This paper presented a model that explains why exchanges have increasingly demutualized in recent years. This is due to the fact that mutual exchanges cannot effectively compete against other exchanges, especially against outsider-owned, for-profit trading platforms. However, we demonstrate that they can survive against competing exchanges when they demutualize. Furthermore, our model explains the ongoing trend of diversification among stock exchanges and shows that outsider-owned exchanges will have a higher propensity to do so vis-à-vis mutual exchanges. Our main results are empirically confirmed by a five year sample of 26 stock exchanges. In particular, we find evidence that competitive pressure induces exchanges to demutualize and that publicly listed exchanges are more likely to invest into related business activities.

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A Discriminatory offers by for-profit exchanges

In the analysis so far, we only allowed for identical offers made by X_2 to the members of the mutual exchange. Let us now assume that the outsider-owned exchange might use discriminatory offers. In this case, an outsider-owned exchange will pursue a divide-and-conquer strategy.[47], which means that the exchange makes a sweet offer to a fraction x of randomly chosen customers of X_1 such that these customers will transfer their new volume to X_2. The remaining $1-x$ do not get this special offer, however they can observe the offer made to the others. Hence, they know that they would have to bear a higher unit fixed cost by staying loyal in the case that X_1 invests and will therefore be individually induced to leave the mutual exchange, which results in a *snowballing* effect.

Thus, X_2 will offer the following trading fee structure to the customers of X_1: The portion x of targeted customers obtain an offer of (or slightly below) $\hat{a} \equiv c - (\theta - \frac{I}{v+k})$. As a result, they will transfer their new volume, since they cannot get a better offer at X_1, even if all members stayed loyal. Furthermore, the outsider-owned exchange will offer the remaining $1-x$ customers a_2 such that

$$a_2(x) \equiv c - (\theta - \frac{I}{v + (1-x)k}). \tag{32}$$

Note that the outsider-owned exchange obtains larger rents from charging the fraction x of customers a trading fee $\hat{a}$ and the remaining customers $1-x$ a fee of $a_2(x) > \hat{a}$, than charging all customers $\hat{a}$. By applying such a divide-and-conquer strategy, the outsider-owned exchange dilutes the customer base of the mutual exchange without offering the defecting customers significantly better conditions from an expected value viewpoint. This strategy will be successful as X_2 knows that a shrinking customer base at X_1 results in higher trading fees for its customers who stay loyal with their new volume, if X_1 decides to invest. This will lower the value of the investment for the mutual stock exchange and reduces its incentive to decide for it at period 0. As a consequence, the second-sourcing effect discovered in the last section loses its relevance in this scenario. Hence, the mutual exchange will have a lower propensity to invest in the project than before.

To show this, we derive the optimal strategy of the for-profit exchange. X_2 offers the customers of X_1 with $x \in [0,1]$ a continuum of offers $a_2(x)$ such that

$$a_2(x) \equiv c - (\theta - \frac{I}{v + (1-x)k}) \qquad \text{for all } x. \tag{33}$$

At the boundaries of x, this translates into the offers $a_2(0) = \hat{a}$ and $a_2(1) = \bar{a} \equiv c - (\theta - \frac{I}{v})$. Note that by using such a strategy, the outsider-owned exchange essentially offers the first member of the continuum the same conditions (or slightly below) she could expect if all other members stayed loyal to the mutual exchange. Since this customer will accept the offer, the second gets an offer that is a little bit worse, and so on. The last customer merely obtains $\bar{a}$, which is equivalent to what it could expect as unit costs if she was the only remaining member who trades

[47]For a general analysis of these strategies, see for instance Segal (2003).

her transferable volume at X_1. Applying this strategy also deters coordination by the members, since everyone runs to be the first in line, thereby getting the best offer from the investor-owned exchange. Essentially, the outsider-owned exchange induces a run amongst the members of the mutual exchange.

Therefore, it is interesting to analyze the parameter values at which the mutual exchange will decide to invest in period 0, taking into account the outlined strategic move by X_2. Since customers will be treated heterogeneously by such a policy, we have to formulate the condition in expected value terms. A representative member can expect a fee of

$$E[a_2(x)] = \check{a} \equiv c - (\theta - \frac{I}{v + \frac{k}{2}}). \tag{34}$$

If the mutual exchange does *not* invest, all members can expect to get conditions such that they are indifferent between changing their volume to exchange X_2 and staying at their home exchange X_1. It follows that they can expect trading costs of $c(v+k)$. However, if the mutual exchange decides to invest into the project, the members can expect trading costs to be at

$$(c - (\theta - \frac{I}{v}))v + \check{a}k \tag{35}$$

From inserting $\check{a} = c - (\theta - \frac{I}{v+\frac{k}{2}})$ into condition (35) we obtain the following condition for investing by a mutual after rearranging:

$$I \leq \frac{(2v+k)(v+k)}{2v+3k}. \tag{36}$$

Only if the investment costs are lower than depicted in condition 36, a mutual exchange operating in the interest of its member will invest into the project. In order to compare this result with the investment cost hurdle of nondiscriminating offers, we obtain:

$$\frac{(2v+k)(v+k)}{2v+3k} \lesseqqgtr \frac{\theta(v+k)^2}{v+2k}. \tag{37}$$

We find that the range of investment costs such that the mutual exchange will invest into the project is *lower* if the investor-owned exchange uses the above formulated divide-and-conquer strategy. In fact,

$$\frac{(2v+k)(v+k)}{2v+3k} < \frac{\theta(v+k)^2}{v+2k} \Leftrightarrow 0 < k(2v+k), \tag{38}$$

which holds, since $v, k > 0$ by assumption. Hence, the mutual exchange has a lower propensity to invest, even though we still observe the "second-sourcing" effect that makes the investment attractive by increasing the bargaining power of its members.

B Multiplicity of Equilibria

Coordination games like the one analyzed in this paper are typically afflicted with the problem of multiple equilibria, where significantly different efficiency outcomes may occur. The global games framework, which we employed, provides a mitigation to this problem. To illustrate that in our analysis, let us consider a situation where the outsider-owned exchange can only make *nondiscriminatory* offers. In the equilibrium we analyzed in section 2.2, the condition on trading costs such that the volume will be transferred to the outsider-owned exchange is

$$a_2 \leq \hat{a} = c - (\bar{\theta} - \frac{I}{v+k}).$$

where $\theta = \bar{\theta}$ is a certain level of efficiency gain. Our analysis implied that each member expects the other members of the mutual exchange to stay until a dominating offer arrives for all of them. This forces the outsider-owned exchange to deliver an offer which is at least as good for the user as the best possible offer of the mutual exchange. Thus in a certain sense, members have bargaining power when they can coordinate their actions and this is anticipated by the outsider-owned exchange. But given a different structure of beliefs by the members, other equilibria are also possible. For instance, if each member believes that the other members will move their new volume as soon as

$$a_2 \leq \bar{a} = c - (\bar{\theta} - \frac{I}{v}),$$

then it is also individually rational to move the new volume if such an offer will be made by the outsider-owned exchange. But, because of $\bar{a} > \hat{a}$ the latter offer is not very attractive for the members of the mutual exchange in total. Hence, we have multiple equilibria with the payoff for each member depending on the equilibrium on which they coordinate. Thus, the outsider-owned exchange is in a situation of strategic uncertainty, since it does not know how the members will react to a given offer. To be on the safe side, it would offer $\hat{a}$ to attract all members with certainty. However, in case it overestimated the coordination abilities of the members, this would be a too costly deal viewed from the perspective of the outside owners whose interests X_2 has to maximize. Therefore, we analyze the circumstances under which the outsider-owned exchange can afford to make an offer which is strictly lower than $\hat{a}$, but nevertheless attracts the total transferable volume k of the mutual's members.

To deal with this issue we draw on the *global games* approach to find an unique equilibrium. The global games approach builds on the idea that individual players, in our case the members of the exchange, are facing payoff uncertainty which is caused by an underlying state of the economy. In our framework, this would correspond to uncertainty regarding the productivity parameter of the investment technology θ. We assume that for each exchange X_i, θ_i is *independently* drawn from the same smooth distribution $F(\theta)$ on the real line with an expected value $E[\theta]$. Furthermore, we assume that the density function $f(\theta)$ is unimodal with *nearly all* its mass lying on the expected value $E[\theta]$. Each member i of the mutual exchange

X_1 receives an individual signal $s_{1,i}$ concerning the project's productivity at its own exchange θ_1, which is distributed *uniformly* on the interval $[\theta_1 - \epsilon, \theta_1 + \epsilon]$ such that for two distinct members $i \neq j$, $s_{1,i}$ is independent of $s_{1,j}$. Regarding the productivity of the outsider-owned exchange, let us assume that all its potential users as well as its outside owners, in whose interests the exchange acts, merely know that this exchange will have an expected productivity gain of $E[\theta]$. Likewise, the outside owners of the for-profit exchange (and its management) also merely know the expected productivity of the investment of the mutual exchange. Hence, we assume that the management of the outsider-owned exchange neither knows the future realization of the productivity state θ_2 of its own exchange nor the productivity state of the mutual exchange θ_1 at the time, at which it has to make its offer a_2 to the members of X_1.[48] Therefore, its offer is based on the expected productivity gain $E[\theta]$. Note that this information structure is in line with our assumption on the time structure and credibility of the offers made by the two exchanges. Since X_2 will move first to make its offer due to its higher commitment to the offer, it is plausible to assume that the members who individually decide over accepting this offer, act later on a better information basis.

For the members of the mutual exchange the payoffs of the game are determined by the underlying state variable θ_1, given the cumulative probability distribution $F(\theta)$. The signal they receive regarding the state variable θ_1 tells them about the payoffs of other members and, crucially, also about the signals that other members are likely to have received. Thus, they possess not only different beliefs, but also different beliefs about the other members' beliefs, and so on. As we will see, this belief structure will determine how they will act in equilibrium.

To understand why this is the case, let us consider an example with just two members $m_i, i = 1, 2$, each with transferable trade volume $k/2$ so that the total adds to k. In essence, both members are playing a coordination game with the following payoffs: The payoff that each member receives, if they both trade its volume $k/2$

	Stay	Withdraw
Stay	$\hat{a}(\theta_1), \hat{a}(\theta_1)$	$\tilde{a}(\theta_1), a_2$
Withdraw	$a_2, \tilde{a}(\theta_1)$	a_2, a_2

Table 4: Payoff Structure with Two Members

at the mutual exchange is equal to

$$\hat{a}(\theta_1) = c - (\theta_1 - \frac{I}{v + k}). \tag{39}$$

If both members accept the offer of the outsider-owned exchange, they each have trading costs of a_2 per unit. However, if only one of the member accepts the offer,

[48] We think that these assumptions on the information structure are quite realistic. Mutual exchanges are owned by its main users who have typically a better information base than outside owners of a for-profit exchange whose only interest is financially motivated and who often lack deeper stock industry knowledge. In addition, it seems plausible that given our time structure the management of the outside-owned exchange at the time it has to announce its offer not yet knows the state of the world.

the remaining member has trading costs of

$$\tilde{a}(\theta_1) \equiv c - (\theta_1 - \frac{I}{v + \frac{k}{2}}). \qquad (40)$$

Hence, $\tilde{a}(\theta_1)$ is clearly higher than $\hat{a}(\theta_1)$. Note that the type of coordination game played depends on the offer a_2 made by X_2, which is a *strategic* variable for this exchange. To examine how the offer by X_2 will be set, we need to analyze two scenarios: The first scenario, as we will see, has an unique equilibrium where both members withdraw if and only if

$$a_2 < \frac{1}{2}(\hat{a}(\theta_1) + \tilde{a}(\theta_1)). \qquad (41)$$

The same logic can be used to show that both members are staying with its transferable volume at the mutual exchange if and only if

$$a_2 \geq \frac{1}{2}(\hat{a}(\theta_1) + \tilde{a}(\theta_1)), \qquad (42)$$

which is our second scenario. To conclude the argument, we have to show that given our assumption on the distribution function of θ, the outsider-owned exchange's optimal choice is an offer a_2 where the trading costs are (slightly lower than) $(\hat{a}(\theta_1) + \tilde{a}(\theta_1))/2$, thereby inducing all the members to transfer its volume to the outsider-owned exchange.

From our assumption regarding the information on the state variable θ_1 which the two members of the mutual exchange X_1 receive, we know that they are highly correlated. Each member will therefore expect trading costs of $\hat{a}(s_{1,i}(\theta_1))$ in case the other member also stays with its volume at X_1, and $\tilde{a}(s_{1,i}(\theta_1))$ if it expects the other member to divert its volume. When observing a certain offer of a_2, which will be derived later on, both members i know that staying with their volume is the best choice for them if both get a signal $s_{1,i}$ concerning the trading costs of its mutual exchange such that

$$\hat{a}(s_{1,i}(\theta_1)) + 2\epsilon < a_2 \qquad \text{for } i = 1, 2. \qquad (43)$$

When both members get such a high signal on the productivity of the investment at their own exchange, they also know that the other's signal will be high enough to prefer to stay at the mutual exchange. This happens because both members know that the other's signal is within 2ϵ of their own signal. For a numerical example, let us normalize the trading offer of the outsider-owned exchange with $a_2 = 1$ and suppose $\epsilon = 0.05$. In this case, if member 1 gets a signal that results in trading costs of $\hat{a}(s_{1,1}) = 0.95$ it can deduce that the true state θ_1 must result in trading costs in the range $0.9 - 1$ and hence that the signal which member 2 gets can only lie in a range that infers trading costs of $0.85 - 1.05$. Only if the signal-related trading cost of member 1 lies at $\hat{a}(s_{1,1}) < 0.9$, it knows that member 2 will also get a signal that induces its to prefer to trade its total volume at the mutual exchange, given the offer $a_2 = 1$ of the outsider-owned exchange. Therefore, if both members get a signal which results in trading costs $\hat{a}(s_{1,i}) < 0.9 = 1 - 2\epsilon$ both members know that they prefer to trade at their exchange X_1.

Going one step further, when do both members know that both members know that both signals are such that both members prefer to trade at its mutual exchange? Hence, we are talking about the *second order* beliefs of the members. By the same argument as given above one can show that only if both signals are such that, given the signal, the trading costs are $\hat{a}(s_{1,i}) < 0.8 = 1 - 4\epsilon$, these second order beliefs will be satisfied. To see this, suppose that member 1 gets a signal indicating its trading costs would be 0.85, given the signal. Member 1 deduces that the true trading costs must lie between 0.8 and 0.9, and hence member 2's signal makes its infer that the trading costs are between 0.75 and 0.95. However, member 1 also has to think about what member 2 would deduce about the signal that member 1 had received. Since member 1 knows that member 2 could have received a signal which produces trading costs of 0.95 it also knows that such a member 2-type would result in a positive probability that the signal of member 1 is in the range $0.85 - 1.05$ as above. Only with signals which lead to trading costs lower than $1 - 4\epsilon = 0.8$, such second order beliefs are excluded and both members know that both members know that both prefer trading at their home exchange.

As we increase the number of order of beliefs, the range of θ_1 will rise. Thus, even with very high productivity parameters θ_1, it can never be *common knowledge* that both members will stay with their volumes at the mutual exchange.

What follows from these higher order beliefs in general? One should analyze the consequences when ϵ is very small. The reason is that such a structure presumes small differences of information among members and therefore can be considered as a relatively minor departure from the basic framework depicted in section 2.1. Since θ is smoothly distributed, this implies that the probability of the signal $s_{1,j}$ of the member j being above or below the signal $s_{1,i}$ of member i for$i \neq j$ approaches 0.5 in each case as $\epsilon \to 0$. Thus, we will take it as 0.5 in following.

How do the members behave in equilibrium? The most natural strategy for each member would be a *switching* strategy, where they only stay with their volume at X_1 if their signal $s_{1,i}$ is at least as large as some threshold value l, and withdraw their additional volume otherwise. Let us suppose that member 1 follows this strategy and member 2 gets a signal $s_{1,2} = l$. What does member 2 infer from the signal that member 1 got? Given that ϵ is very small and θ_1 is drawn from a smooth distribution, member 2 deduces a probability of 0.5 that $s_{1,1} < l$ and that member 1 will withdraw its transferable volume and with a probability of 0.5 that $s_{1,1} \geq l$ and that member 1 will stay with its volume at the mutual exchange, according to the presumed switching strategy. Hence, the trading cost of member 2 from *staying* is

$$0.5\hat{a} + 0.5\tilde{a} = 0.5(c - (\theta_1 - \frac{I}{v+k}) + c - (\theta_1 - \frac{I}{v+\frac{k}{2}})) = c - (\theta_1 - \frac{I}{v+\frac{3k}{4}}), \quad (44)$$

and the trading costs from withdrawing is

$$0.5a_2 + 0.5a_2 = a_2. \quad (45)$$

Therefore, member 2 will withdraw if

$$a_2 < c - (\theta_1 - \frac{I}{v + \frac{3k}{4}}). \tag{46}$$

If condition (46) is satisfied, then member 2 will withdraw. In fact, it will withdraw even when its signal $s_{1,2} = l$ is higher than l, but lower than some cutoff point l^*, where it is indifferent between staying and withdrawing in terms of expected trading costs. However, now again we have an infection argument of the kind described above going on. Since both members are in symmetric positions, using the same argument one can show that member 1 will have a cutoff point higher than l^*. That is a contradiction with the initial assumption that member 1 will remain at the mutual exchange and therefore both members staying with its volume at the mutual exchange cannot be an equilibrium. Instead, both members will always withdraw in equilibrium, if condition (46) is satisfied, and for small values of ϵ this equilibrium is indeed unique.[49]

Hence, we have shown that withdrawing is the only remaining equilibrium if the outsider-owned exchange makes an offer a_2 to both members similar to the one depicted in condition (46). Note that the payoff of retaining the volume at the mutual exchange depends on θ_1, which we have assumed to be a random variable. However, given our assumption that the density function of θ has nearly all its mass on its mean $E[\theta]$, the outsider-owned exchange can expect that θ_1 will be close to this parameter. Substituting $E[\theta]$ for θ_1 in condition (46) gives us a condition for an optimal offer of the outsider-owned exchange such that the outsider-owned exchange can expect that members of the mutual exchange to withdraw their volume. As can be seen from equation (44), this optimal offer corresponds to condition (41) given above. In consequence, the outsider-owned exchange will succeed in destabilizing the mutual. Note also that the resulting equilibrium is the *risk-dominant* equilibrium which always implies some coordination failure among the members.

Generalizing to the case with a continuum of traders we can focus on the risk-dominant equilibrium which is the unique equilibrium when the perception of a small payoff uncertainty exists, as shown by the global games approach. Hence, given this equilibrium the outsider-owned exchange X_2 will set the offer $a_2 < \check{a}$ such that the trading costs are slightly lower than

$$\check{a} \equiv c - (\theta - \frac{I}{v + \frac{k}{2}}). \tag{47}$$

The condition corresponds to the one given in section 2.2.1.

[49] The argument used to eliminate an equilibrium depends on members using a switching strategy, where below some signal level, the members withdraw and above some level they stay with their volume at the mutual exchange. Naturally, there also exist other strategies. However, Morris and Shin (2003) show that switching strategies are optimal in the global games approach.

C Stock exchanges employed in regressions

No.	Exchange	Governance			Related Activities		
		Mutual/State	Demutualized	Listed	Post-Trading	Derivatives	Software
1	Australian	-	1998-	1998-	√	√	-
2	BOVESPA	√	-	-	-	√	-
3	Budapest	-	2002-	-	-	√	-
4	Copenhagen	-	1996-	-	2000-	√	-
5	Deutsche Börse	-	2000-	2001-	2000-	√	√
6	Euronext†	-	2000-	2001-	√	√	√
7	Hellenic*	-	1995-	2000-	2000-	2002-	2000-
8	Hongkong	-	2000-	2000-	√	√	-
9	Istanbul	√	-	-	-	2001-	-
10	Jakarta	√	-	-	√	-	-
11	Johannesburg JSE	√	-	-	√	2001-	-
12	Kuala Lumpur	√	-	-	√	√	-
13	Lima	-	2003-	-	-	2003-	-
14	London	-	2000-	2001-	-	2003-	-
15	NASDAQ	-	2001-	-	-	-	-
16	NYSE	√	-	-	-	-	-
17	OMX	-	1993-	1998-	2001-	√	√
18	Oslo	-	2001-	-	-	√	-
19	Philippine	-	2001-	-	2003-	-	-
20	Singapore SGX†	-	1999-	2000-	√	√	2000-
21	SWX Zurich	-	2002-	-	-	√	-
22	Taiwan	√	-	-	√	-	-
23	Thailand	√	-	-	√	-	-
24	Tokyo	-	2001-	-	√	√	2002-
25	Toronto TSX	-	2000-	2002-	-	-1999	2002-
26	Vienna	-	1998-	-	2000-	√	-
	Total	9	17	9	17	20	7

*: Athens Stock Exchange in 1999
†: Pro forma figures for 1999
√: Exchange possessed this activity since 1999 or earlier

Table 5: Exchanges Included in Probit Regressions (1999-2003)

D Correlation Matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)	SETTLE	1									
(2)	DERIVAT	0.144	1								
(3)	SOFTWARE	0.217	0.27	1							
(4)	DEMUT	0.081	0.294	0.408	1						
(5)	LISTED	0.268	0.235	0.548	0.566	1					
(6)	BOARDCOMP	0.037	0.105	-0.087	-0.33	-0.192	1				
(7)	DELTRADEREV	0.082	-0.033	-0.098	-0.07	-0.076	0.06	1			
(8)	CMCONTROL	-0.315	0.189	0.28	0.442	0.287	-0.179	-0.025	1		
(9)	TRADECOST	0.221	-0.311	-0.285	-0.285	-0.152	0.131	0.122	-0.517	1	
(10)	SIZE	-0.077	-0.147	0.216	-0.001	0.162	-0.224	-0.089	0.275	-0.539	1

Table 6: Correlation of Employed Variables (1999-2003 Pooled)

E Robustness Checks

	Univariate Probit Regressions (clustering)			
(1)	(2)	(3)	(4)	(5)
Related Business Activity:	**DEMUT**	**SETTLE**	**DERIV**	**SOFTWARE**
LISTED		**1.149*****	**0.893****	**1.719*****
Std. Err.		*0.415*	*0.396*	*0.505*
BOARDCOMP	**-2.600*****	**0.563**	**0.709**	**0.283**
Std. Err.	*0.910*	*0.942*	*0.907*	*0.857*
ΔTRADEREV	**-0.202**	**0.867**	**0.002**	**-0.317**
Std. Err.	*0.437*	*1.239*	*0.305*	*0.278*
CMCONTROL	**0.303*****	**-0.344*****	**-0.03**	**0.139**
Std. Err.	*0.113*	*0.121*	*0.138*	*0.213*
TRADECOST	**-0.024***	**0.011**	**-0.057*****	**-0.039***
Std. Err.	*0.013*	*0.013*	*0.015*	*0.023*
SIZE	**-0.268*****	**0.056**	**-0.375****	**0.004**
Std. Err.	*0.096*	0.111	0.16	*0.118*
CONST	**3.325***	**0.433**	**6.488*****	**-1.756**
Std. Err.	*1.808*	*2.104*	*2.392*	*2.823*
Observations	130	130	130	130
Wald $-\chi^2$	28.73	23.52	19.42	19.95

	Univariate Probit Regressions (Random Effects)			
(1)	(2)	(3)	(4)	(5)
Related Business Activity:	**DEMUT**	**SETTLE**	**DERIV**	**SOFTWARE**
LISTED		**1.325*****	**-0.347**	**7.853*****
Std. Err.		*0.384*	*0.925*	*3.200*
BOARDCOMP	**-4.105*****	**0.240**	**2.560†**	**-2.912†**
Std. Err.	*1.472*	*0.835*	*1.634*	*2.023*
ΔTRADEREV	**-0.275**	**0.424**	**-0.344**	**-1.533**
Std. Err.	*0.413*	*0.356*	*0.969*	*1.548*
CMCONTROL	**0.323****	**-0.299*****	**0.188**	**0.838†**
Std. Err.	*0.166*	*0.123*	*0.259*	*0.594*
TRADECOST	**-0.037****	**0.006**	**-0.127*****	**-0.155*****
Std. Err.	*0.019*	*0.012*	*0.040*	*0.057*
SIZE	**-0.428****	**0.014**	**-0.807*****	**1.244†**
Std. Err.	*0.184*	0.100	0.244	*0.822*
CONST	**6.401****	**1.185**	**12.282*****	**-23.021***
Std. Err.	*3.279*	*1.886*	*5.248*	*13.372*
Observations	130	130	130	130
Wald $-\chi^2$	14.94	15.78	16.57	8.63

	Univariate Logit Regressions (Random Effects)			
(1)	(2)	(3)	(4)	(5)
Related Business Activity:	**DEMUT**	**SETTLE**	**DERIV**	**SOFTWARE**
LISTED		**4.962*****	**1.124**	**7.390*****
Std. Err.		*1.565*	-	*2.751*
BOARDCOMP	**-7.274*****	**1.993**	**4.633**	**-4.447**
Std. Err.	*2.803*	*3.614*	-	*3.803*
ΔTRADEREV	**-0.476**	**-0.148**	**0.213**	**-2.155**
Std. Err.	*0.743*	*1.254*	*1.413*	*2.146*
CMCONTROL	**0.568***	**-1.309*****	**0.327**	**0.813**
Std. Err.	*0.304*	*0.521*	-	*0.953*
TRADECOST	**-0.065****	**-0.064**	**-0.186*****	**-0.269*****
Std. Err.	*0.034*	*0.047*	*0.064*	*0.101*
SIZE	**-0.777****	**-0.294**	**-1.891*****	**-0.006**
Std. Err.	*0.343*	0.285	0.556	0.559
CONST	**11.583***	**10.024***	**26.103*****	**-2.245**
Std. Err.	*6.302*	*6.057*	*8.833*	-
Observations	130	130	130	130
Wald $-\chi^2$	13.21	13.31	-	10.80

Table 7: Univariate Regressions

F Event Studies

This section describes the methodology used in figure 2. We first discuss the construction of the event study for the degree of diversification.

In a first step, we identified from our sample of 50 largest exchanges those that demutualized or went public in the five year time frame 1999-2003, and labeled them as 'Demutualized Group' (16 exchanges) and 'IPO Group' (7 exchanges), respectively. Thus, these exchanges were subject to the 'event' under consideration. We then identified those exchanges that remained mutuals during 1999 and 2003, which we denoted as 'Control Group' (25 exchanges). For each of the considered exchanges we counted the number of related activities they offered in each year. We then divided the sums by the amount of possible related activities in each year. Since we considered three related activities (derivatives, post-trading, software), each exchange was assigned a value of either zero (no related activities), 1/3, 2/3 or one (all three related activities) for each year. We then adjusted the fractions of the 'Demutualized Group' and 'IPO Group'-exchanges by deducting the 'Control Group's mean degree of diversification from it, for each year. This provided us an indication by how much the two groups' degree of diversification differs from that of the 'Control Group'. Then, we aligned the calculated values for the two groups according to the timing of the respective event. To be more specific, we rearranged the values for each of the exchanges of the 'Demutualized Group' and the 'IPO Group' in such a way that their values occurred at the same time, i.e. either prior (t-2, t-1), at (t), or after the event (t+1, t+2). Finally, we calculated the mean values of diversification for each of these time periods. The results for demutualization and IPO can be seen in tables 8 and tables 9, respectively.

In analogy to the procedure outlined above, conducted an event study that measured the change in revenue growth for the three groups of exchanges. In a first step, we again identified those exchanges that qualify for the event. In contrast to the approach above, we selected the exchanges from a smaller sample, as we do not have financial statement data for all of the 50 largest exchanges. This reduced our considered subsamples 'Demutualized Group', 'IPO Group' and 'Control Group' to 13, 7, and 13 exchanges, respectively. For the 'Demutualized Group' and 'IPO Group', we calculated the development in revenues by indexing them at the period in which the event occurred, i.e. the revenues of 2001 were used as base year, if the event took place in that year. For the exchanges of the control group we calculated these indices for several starting points separately, depending on the years an event had occurred in the 'Demutualized Group' and 'IPO Group'. To be more specific, we calculated the indices with the base years 1999, 2000, 2001 and 2002 in the event of demutualization as there occurred this event in these years. We the matched the exchanges from the 'Demutualized Group' and 'IPO Group' with the corresponding 'Control Group' tables and adjusted the revenue index as in analogy with the former event study. Then, as before, we aligned the calculated values for the 'Demutualized Group' and the 'IPO Group' according to the timing of the respective event and calculated mean values for each time period. The results can be seen in tables 10 and tables 11, respectively.

No.	Diversification - Demutualized Group	1999	2000	2001	2002	2003
1	Singapore (1999)	0.67	1.00	1.00	1.00	1.00
2	TSX (2000)	0.33	0.00	0.00	0.33	0.33
3	Deutsche Börse (2000)	0.67	1.00	1.00	1.00	1.00
4	Euronext (2000)	1.00	1.00	1.00	1.00	1.00
5	London (2000)	0.00	0.00	0.00	0.00	0.33
6	Hong Kong (2000)	0.67	0.67	0.67	0.67	0.67
7	Mexico Stock Exchange (2001)	0.00	0.00	0.00	0.00	0.00
8	Nasdaq (2001)	0.00	0.00	0.00	0.00	0.00
9	Oslo (2001)	0.33	0.33	0.33	0.33	0.33
10	Osaka (2001)	0.67	0.67	0.67	0.67	0.67
11	Philippine (2001)	0.00	0.00	0.00	0.00	0.33
12	Tokyo (2001)	0.67	0.67	0.67	1.00	1.00
13	Swiss Exchange (2002)	0.00	0.00	0.00	0.00	0.00
14	Spanish Exchanges (2002)	0.00	0.00	0.00	0.00	0.00
15	Budapest (2002)	0.33	0.33	0.33	0.33	0.33
16	Lima (2003)	0.00	0.00	0.00	0.00	0.33

No.	Diversification - Control Group	1999	2000	2001	2002	2003
1	Amex	0.33	0.33	0.33	0.33	0.33
2	Buenos Aires	0.67	0.67	0.67	0.67	0.67
3	Chicago Stock Exchange	0.00	0.00	0.00	0.00	0.00
4	Colombo	0.33	0.33	0.33	0.33	0.33
5	Irish	0.00	0.00	0.00	0.00	0.00
6	Istanbul	0.00	0.00	0.33	0.33	0.33
7	Jakarta	0.33	0.33	0.33	0.33	0.33
8	JSE South Africa	0.33	0.33	0.67	0.67	0.67
9	Korea	0.67	0.67	0.67	0.67	0.67
10	Kuala Lumpur	0.67	0.67	0.67	0.67	0.67
11	Ljubljana	0.00	0.00	0.00	0.00	0.00
12	Luxembourg	0.00	0.00	0.00	0.00	0.00
13	Malta	0.33	0.33	0.33	0.33	0.33
14	Mumbai	0.33	0.33	0.33	0.33	0.33
15	NYSE	0.00	0.00	0.00	0.00	0.00
16	Santiago	0.00	0.00	0.00	0.00	0.00
17	Sao Paulo	0.33	0.33	0.33	0.33	0.33
18	Shanghai	0.00	0.00	0.00	0.00	0.00
19	Shenzhen	0.33	0.33	0.33	0.33	0.33
20	Taiwan	0.33	0.33	0.33	0.33	0.33
21	Tehran	0.33	0.33	0.33	0.33	0.33
22	Tel-Aviv	0.67	0.67	0.67	0.67	0.67
23	Thailand	0.33	0.33	0.33	0.33	0.33
24	Warsaw	0.33	0.33	0.33	0.33	0.33
	Mean	0.28	0.28	0.31	0.31	0.31
	Median	0.33	0.33	0.33	0.33	0.33

No.	Control Group mean-adjusted	1999	2000	2001	2002	2003
1	Singapore	0.39	0.72	0.69	0.69	0.69
2	TSX	0.06	-0.28	-0.31	0.03	0.03
3	Deutsche Börse	0.39	0.72	0.69	0.69	0.69
4	Euronext	0.72	0.72	0.69	0.69	0.69
5	London	-0.28	-0.28	-0.31	-0.31	0.03
6	Hong Kong	0.39	0.39	0.36	0.36	0.36
7	Mexico Stock Exchange	-0.28	-0.28	-0.31	-0.31	-0.31
8	Nasdaq	-0.28	-0.28	-0.31	-0.31	-0.31
9	Oslo	0.06	0.06	0.03	0.03	0.03
10	Osaka	0.39	0.39	0.36	0.36	0.36
11	Philippine	-0.28	-0.28	-0.31	-0.31	0.03
12	Tokyo	0.39	0.39	0.36	0.69	0.69
13	Swiss Exchange	-0.28	-0.28	-0.31	-0.31	-0.31
14	Spanish Exchanges	-0.28	-0.28	-0.31	-0.31	-0.31
15	Budapest	0.06	0.06	0.03	0.03	0.03
16	Lima	-0.28	-0.28	-0.28	-0.28	0.06

No.	Event-adjusted (Demutualization)	t-2	t-1	t	t+1	t+2
1	Singapore			0.39	0.72	0.69
2	TSX		0.06	-0.28	-0.31	0.03
3	Deutsche Börse		0.39	0.72	0.69	0.69
4	Euronext		0.72	0.72	0.69	0.69
5	London		-0.28	-0.28	-0.31	-0.31
6	Hong Kong		0.39	0.39	0.36	0.36
7	Mexico Stock Exchange	-0.28	-0.28	-0.31	-0.31	-0.31
8	Nasdaq	-0.28	-0.28	-0.31	-0.31	-0.31
9	Oslo	0.06	0.06	0.03	0.03	0.03
10	Osaka	0.39	0.39	0.36	0.36	0.36
11	Philippine	-0.28	-0.28	-0.31	-0.31	0.03
12	Tokyo	0.39	0.39	0.36	0.69	0.69
13	Swiss Exchange	-0.28	-0.31	-0.31	-0.31	
14	Spanish Exchanges	-0.28	-0.31	-0.31	-0.31	
15	Budapest	0.06	0.03	0.03	0.03	
16	Lima	-0.28	-0.28	0.06		
	Median Demutualization	-0.28	0.03	0.03	0.03	0.19
	Mean Demutualization	-0.08	0.03	0.06	0.10	0.22

Table 8: Diversification Data for Event Studies on Demutualization

No.	Diversification - IPO Group	1999	2000	2001	2002	2003
1	Hellenic Exchanges (2000)	0.00	0.67	0.67	1	1
2	Hong Kong (2000)	0.67	0.67	0.67	0.67	0.67
3	Singapore (2000)	0.67	1.00	1.00	1.00	1.00
4	Deutsche Börse (2001)	0.67	1.00	1.00	1.00	1.00
5	Euronext (2001)	1.00	1.00	1.00	1.00	1.00
6	London (2001)	0.00	0.00	0.00	0.00	0.33
7	TSX (2002)	0.33	0.00	0.00	0.33	0.33

No.	Diversification - Control Group	1999	2000	2001	2002	2003
1	Amex	0.33	0.33	0.33	0.33	0.33
2	Buenos Aires	0.67	0.67	0.67	0.67	0.67
3	Chicago Stock Exchange	0.00	0.00	0.00	0.00	0.00
4	Colombo	0.33	0.33	0.33	0.33	0.33
5	Irish	0.00	0.00	0.00	0.00	0.00
6	Istanbul	0.00	0.00	0.33	0.33	0.33
7	Jakarta	0.33	0.33	0.33	0.33	0.33
8	JSE South Africa	0.33	0.33	0.67	0.67	0.67
9	Korea	0.67	0.67	0.67	0.67	0.67
10	Kuala Lumpur	0.67	0.67	0.67	0.67	0.67
11	Ljubljana	0.00	0.00	0.00	0.00	0.00
12	Luxembourg	0.00	0.00	0.00	0.00	0.00
13	Malta	0.33	0.33	0.33	0.33	0.33
14	Mumbai	0.33	0.33	0.33	0.33	0.33
15	NYSE	0.00	0.00	0.00	0.00	0.00
16	Santiago	0.00	0.00	0.00	0.00	0.00
17	Sao Paulo	0.33	0.33	0.33	0.33	0.33
18	Shanghai	0.00	0.00	0.00	0.00	0.00
19	Shenzhen	0.33	0.33	0.33	0.33	0.33
20	Taiwan	0.33	0.33	0.33	0.33	0.33
21	Tehran	0.33	0.33	0.33	0.33	0.33
22	Tel-Aviv	0.67	0.67	0.67	0.67	0.67
23	Thailand	0.33	0.33	0.33	0.33	0.33
24	Warsaw	0.33	0.33	0.33	0.33	0.33
	Mean	0.28	0.28	0.31	0.31	0.31
	Median	0.33	0.33	0.33	0.33	0.33

No.	Control Group mean-adjusted	1999	2000	2001	2002	2003
1	Hellenic Exchanges	-0.28	0.39	0.36	0.69	0.69
2	Hong Kong	0.39	0.39	0.36	0.36	0.36
3	Singapore	0.39	0.72	0.69	0.69	0.69
4	Deutsche Börse	0.39	0.72	0.69	0.69	0.69
5	Euronext	0.72	0.72	0.69	0.69	0.69
6	London	-0.28	-0.28	-0.31	-0.31	0.03
7	TSX	0.06	-0.28	-0.31	0.03	0.03

No.	Event-adjusted (IPO)	t-2	t-1	t	t+1	t+2
1	Hellenic Exchanges		-0.28	0.39	0.36	0.69
2	Hong Kong		0.39	0.39	0.36	0.36
3	Singapore		0.39	0.72	0.69	0.69
4	Deutsche Börse	0.39	0.72	0.69	0.69	0.69
5	Euronext	0.72	0.72	0.69	0.69	0.69
6	London	-0.28	-0.28	-0.31	-0.31	0.03
7	TSX	-0.28	-0.31	0.03	0.03	
	Mean IPO	0.14	0.19	0.37	0.36	0.53
	Median IPO	0.06	0.39	0.39	0.36	0.69

Table 9: Diversification Data for Event Studies on IPO

No.	Demutualized Group indexed at Event	1999	2000	2001	2002	2003
1	Singapore (1999)	1.00	0.90	1.10	1.10	1.32
2	TSX (2000)	0.70	1.00	0.80	0.96	1.04
3	Deutsche Börse (2000)	0.90	1.00	1.08	1.58	2.35
4	Euronext (2000)	1.14	1.00	1.41	2.02	2.01
5	London (2000)	0.90	1.00	1.14	1.20	1.27
6	Hong Kong (2000)	0.71	1.00	0.85	0.82	0.90
7	Nasdaq (2001)	0.74	0.97	1.00	0.93	0.69
8	Oslo (2001)	0.69	0.88	1.00	1.00	1.02
9	Philippine (2001)	1.30	2.02	1.00	0.99	0.70
10	Tokyo (2001)	0.94	0.97	1.00	0.95	1.05
11	Swiss Exchange (2002)	0.58	0.74	0.97	1.00	1.02
12	Budapest (2002)	1.32	1.37	0.97	1.00	1.07
13	Lima (2003)	1.59	1.41	1.05	0.93	1.00

No.	Control Group - Indexed at 1999	1999	2000	2001	2002	2003
1	Chicago	1.00	1.35	1.29	1.05	0.88
2	Istanbul	1.00	2.05	1.63	1.45	1.97
3	Jakarta	1.00	1.02	1.04	1.08	1.15
4	JSE South Africa	1.00	1.22	1.51	1.64	1.56
5	Kuala Lumpur	1.00	0.67	0.39	0.37	0.69
6	Ljubljana	1.00	1.20	1.36	1.74	1.44
7	Malta	1.00	1.22	1.27	1.38	1.38
8	NYSE	1.00	1.12	1.51	1.49	1.51
9	Sao Paulo	1.00	0.99	0.88	0.83	1.00
10	Taiwan	1.00	1.06	0.73	0.75	0.69
11	Thailand	1.00	1.02	0.99	1.15	1.71
12	Warsaw	1.00	1.41	0.99	0.72	0.89
	Mean	1.00	1.19	1.13	1.14	1.24
	Median	1.00	1.16	1.15	1.11	1.26

	Control Group - Indexed at 2000	1999	2000	2001	2002	2003
	Mean	0.89	1.00	0.95	0.96	1.06
	Median	0.86	1.00	0.97	0.94	1.08
	Control Group - Indexed at 2001	**1999**	**2000**	**2001**	**2002**	**2003**
	Mean	1.02	1.12	1.00	1.00	1.14
	Median	0.88	1.04	1.00	1.01	1.07
	Control Group - Indexed at 2002	**1999**	**2000**	**2001**	**2002**	**2003**
	Mean	1.05	1.16	1.02	1.00	1.15
	Median	0.90	1.08	0.99	1.00	1.04
	Control Group - Indexed at 2003	**1999**	**2000**	**2001**	**2002**	**2003**
	Mean	0.90	1.03	0.94	0.92	1.00
	Median	0.80	0.93	0.93	0.96	1.00

No.	Control Group mean-adjusted	1999	2000	2001	2002	2003
1	Singapore	0.00	-0.29	-0.03	-0.03	0.08
2	TSX	-0.20	0.00	-0.14	0.00	-0.02
3	Deutsche Börse	0.01	0.00	0.14	0.61	1.29
4	Euronext	0.25	0.00	0.47	1.06	0.95
5	London	0.01	0.00	0.20	0.24	0.21
6	Hong Kong	-0.19	0.00	-0.10	-0.15	-0.16
7	Nasdaq	-0.28	-0.15	0.00	-0.07	-0.45
8	Oslo	-0.33	-0.24	0.00	0.00	-0.11
9	Philippine	0.28	0.91	0.00	0.00	-0.44
10	Tokyo	-0.08	-0.14	0.00	-0.05	-0.08
11	Swiss Exchange	-0.47	-0.42	-0.05	0.00	-0.13
12	Budapest	0.27	0.21	-0.05	0.00	-0.07
13	Lima	0.68	0.38	0.12	0.00	0.00

No.	Event-adjusted (Demutualization)	t-2	t-1	t	t+1	t+2
1	Singapore			0.00	-0.29	-0.03
2	TSX		-0.20	0.00	-0.14	0.00
3	Deutsche Börse		0.01	0.00	0.14	0.61
4	Euronext		0.25	0.00	0.47	1.06
5	London		0.01	0.00	0.20	0.24
6	Hong Kong		-0.19	0.00	-0.10	-0.15
7	Nasdaq	-0.28	-0.15	0.00	-0.07	-0.45
8	Oslo	-0.33	-0.24	0.00	0.00	-0.11
9	Philippine	0.28	0.91	0.00	0.00	-0.44
10	Tokyo	-0.08	-0.14	0.00	-0.05	-0.08
11	Swiss Exchange	-0.42	-0.05	0.00	-0.13	
12	Budapest	0.21	-0.05	0.00	-0.07	
13	Lima	0.12	0.00	0.00		
	Median Demutualization	-0.08	-0.05	0.00	-0.06	-0.06
	Mean Demutualization	-0.07	0.01	0.00	-0.01	0.07

Table 10: Operating Revenue Data for Event Studies on Demutualization

No.	IPO Group Revenues Indexed at Event	1999	2000	2001	2002	2003
1	Hellenic Exchanges (2000)	1.84	1.00	1.50	0.98	1.22
2	Hong Kong (2000)	0.71	1.00	0.85	0.82	0.90
3	Singapore (2000)	1.11	1.00	1.22	1.22	1.46
4	Deutsche Börse (2001)	0.84	0.92	1.00	1.46	2.17
5	Euronext (2001)	0.80	0.71	1.00	1.43	1.42
6	London (2001)	0.79	0.88	1.00	1.05	1.11
7	TSX (2002)	0.72	1.04	0.83	1.00	1.08

No.	Control Group - Revenues Indexed at 2000	1999	2000	2001	2002	2003
1	Chicago	0.74	1.00	0.96	0.78	0.65
2	Istanbul	0.49	1.00	0.79	0.71	0.96
3	Jakarta	0.98	1.00	1.01	1.05	1.12
4	JSE South Africa	0.82	1.00	1.24	1.35	1.28
5	Kuala Lumpur	1.50	1.00	0.59	0.56	1.04
6	Ljubljana	0.83	1.00	1.13	1.45	1.20
7	Malta	0.82	1.00	1.04	1.12	1.13
8	NYSE	0.89	1.00	1.35	1.33	1.35
9	Sao Paulo	1.01	1.00	0.89	0.83	1.01
10	Taiwan	0.95	1.00	0.69	0.71	0.66
11	Thailand	0.98	1.00	0.98	1.13	1.68
12	Warsaw	0.71	1.00	0.70	0.51	0.63
	Mean	0.89	1.00	0.95	0.96	1.06
	Median	0.86	1.00	0.97	0.94	1.08

	Control Group - Indexed at 2001	1999	2000	2001	2002	2003
	Mean	1.02	1.12	1.00	1.00	1.14
	Median	0.88	1.04	1.00	1.01	1.07

	Control Group - Indexed at 2002	1999	2000	2001	2002	2003
	Mean	1.05	1.16	1.02	1.00	1.15
	Median	0.90	1.08	0.99	1.00	1.04

No.	Control Group mean-adjusted	1999	2000	2001	2002	2003
1	Hellenic Exchanges	0.94	0.00	0.56	0.02	0.16
2	Hong Kong	-0.19	0.00	-0.10	-0.15	-0.16
3	Singapore	0.21	0.00	0.27	0.26	0.40
4	Deutsche Börse	-0.19	-0.19	0.00	0.46	1.03
5	Euronext	-0.22	-0.41	0.00	0.43	0.28
6	London	-0.23	-0.24	0.00	0.05	-0.02
7	TSX	-0.33	-0.12	-0.19	0.00	-0.06

No.	Event-adjusted (IPO)	t-2	t-1	t	t+1	t+2
1	Hellenic Exchanges		0.94	0.00	0.56	0.02
2	Hong Kong		-0.19	0.00	-0.10	-0.15
3	Singapore		0.21	0.00	0.27	0.26
4	Deutsche Börse	-0.19	-0.19	0.00	0.46	1.03
5	Euronext	-0.22	-0.41	0.00	0.43	0.28
6	London	-0.23	-0.24	0.00	0.05	-0.02
7	TSX	-0.12	-0.19	0.00	-0.06	
	Mean IPO	-0.19	-0.01	0.00	0.23	0.24
	Median IPO	-0.20	-0.19	0.00	0.27	0.14

Table 11: Operating Revenue Data for Event Studies on IPO