Written Exam for the M.Sc. in Economics summer 2011

**Financial Markets**

Final Exam

August 20, 2011 at 10.00 until August 22, 2011 at 10.00

Please note that the language used in your exam paper must correspond to the language of the title for which you registered during exam registration. I.e. if you registered for the English title of the course, you must write your exam paper in English. Likewise, if you registered for the Danish title of the course or if you registered for the English title which was followed by "eksamen på dansk" in brackets, you must write your exam paper in Danish.

If you are in doubt about which title you registered for, please see the print of your exam registration from the students' self-service system.

***The paper must be uploaded as <u>one PDF document</u> (including the standard cover and the appendices). The PDF document must be named with exam number only (e.g. '1234.pdf') and uploaded to Absalon.***

**Focus on Exam Cheating**

In case of presumed exam cheating, which is observed by either the examination registration of the respective study programmes, the invigilation or the course lecturer, the Head of Studies will make a preliminary inquiry into the matter, requesting a statement from the course lecturer and possibly the invigilation, too. Furthermore, the Head of Studies will interview the student. If the Head of Studies finds that there are reasonable grounds to suspect exam cheating, the issue will be reported to the Rector. In the course of the study and during examinations, the student is expected to conform to the rules and regulations governing academic integrity. Academic dishonesty includes falsification, plagiarism, failure to disclose information, and any other kind of misrepresentation of the student's own performance and results or assisting another student herewith. For example failure to indicate sources in written assignments is regarded as failure to disclose information. Attempts to cheat at examinations are dealt with in the same manner as exam cheating which has been carried through. In case of exam cheating, the following sanctions may be imposed by the Rector:

● 1. A warning

● 2. Expulsion from the examination

● 3. Suspension from the University for at limited period or permanent expulsion.

Please answer all 3 problems and all sub-questions below.

# Problem 1:

(a) Explain intuitively how liquidity risk may influence asset prices.

(b) The textbook mentions on page 87 that imperfect competition decreases liquidity supplied by inventory-holding dealers. Intuitively explain this effect.

(c) It has been observed that market orders in opposite directions are less frequent than market orders in identical directions, over a short span of time. Explain this result with reference to the Parlour (1998) model.

# Problem 2:

This problem considers the possibility of manipulating asset prices in the Glosten-Milgrom model. It is related to chapter 4 of the textbook and the lecture slides of February 18.

The competitive, risk-neutral price-setting market makers all work under the assumption that the following model is correct. The traded asset has unknown value $V$ which is either 0 or 1. We denote $\theta = E[V] = \Pr(V = 1)$. Traders arrive sequentially to trade. Each trader can buy or sell one unit of the asset. Conditional on $V$, trader types are identically and independently distributed as follows: there is chance $\alpha$ that the trader is risk-neutral and informed about the true $V$, chance $(1 - \alpha)\beta$ that the trader is an uninformed buyer and chance $(1 - \alpha)(1 - \beta)$ that the trader is an uninformed seller.

The analysis in the book and the slides concludes that the equilibrium of the model has the following property. When $V = 1$ every informed trader will buy the asset, when $V = 0$ every informed trader will sell the asset. Given an observed history $h_t$ of the first $t$ realized trades, market makers have Bayes rationally updated their beliefs about $V$. They quote bid and ask prices taking into account the next trade. The ask price for trader $t + 1$ is thus $a_{t+1} = \Pr(V = 1|h_t, B_{t+1})$ and the bid price is $b_{t+1} = \Pr(V = 1|h_{t+1}, S_{t+1})$.

We now depart from the book's analysis. Suppose that the trader arriving to the market at time 1 is a risk-neutral manipulator. The manipulator has no information, and hence

shares the market makers' beliefs about $V$. The special feature of the manipulator is that this trader is allowed to trade twice — now, in period $t = 1$, and again at some fixed future date $t = T > 1$. Note that we assume that the market makers know nothing about this.

Our goal is to investigate whether it is profitable for the manipulator to buy one unit of the asset at time 1 (thereby pushing up the market makers' expectations about $V$) and sell the asset again at time $T$ (realizing profits from the higher price level). The manipulator, like the market makers, cannot know at time 1 what will be the realized sequence $\tilde{h}$ of trades at times $2, \ldots, T - 1$. For any realization $h$ of $\tilde{h}$, market makers will come to buy back the asset from the manipulator at price $b_T = \Pr(V = 1|B_1, h, S_T)$.

(a) Bayes' rule, for arbitrary information set $I$, says that

$$\Pr(V = 1|I) = \frac{\theta \Pr(I|V = 1)}{\theta \Pr(I|V = 1) + (1 - \theta)\Pr(I|V = 0)}.$$

Show that this can be rewritten as

$$\frac{\Pr(V = 1|I)}{1 - \Pr(V = 1|I)} = \frac{\theta \Pr(I|V = 1)}{(1 - \theta)\Pr(I|V = 0)}. \tag{1}$$

In the following, it may help to note that $p/(1 - p)$ is an increasing function of $p \in (0, 1)$.

(b) Suppose $T = 2$. Argue that market makers have $\Pr(B_1, S_2|V) = \Pr(B_1|V)\Pr(S_2|V)$. Write down an expression for $\Pr(S_2|V)$ and verify that $\Pr(S_2|V = 0) > \Pr(S_2|V = 1)$. Use equation (1) to verify that $b_2 < a_1$. Conclude that the manipulation attempt is unprofitable when $T = 2$. Discuss intuitively, why the manipulator cannot realize profits at time 2 from having pushed up the price at time 1.

(c) Consider the case $T > 2$. Argue again that market makers have $\Pr(B_1, h, S_T|V) = \Pr(B_1|V)\Pr(h|V)\Pr(S_T|V)$. Use equation (1) to show that the market makers' belief after history $(B_1, h, S_T)$ is the same as if the same realized trades $h$ were to come last, i.e., $\Pr(V = 1|B_1, h, S_T) = \Pr(V = 1|B_1, S_2, h)$.

(d) The law of iterated expectation holds in general for Bayes updated beliefs. For our purpose, it says that when information set $J$ includes all the information in $I$, then $E[E[V|J]|I] = E[V|I]$. Thus, if you currently know $I$ but do not yet know the rest of

$J$, your current expectation about what will be your future expectation about $V$ is equal to the current expectation about $V$. Use this law to show that $E\left[E\left[V|B_1, S_2, h\right]|B_1, S_2\right] = E\left[V|B_1, S_2\right]$. Combine this with the result in (c) to show that the manipulator can expect $b_T$ to be equal to the price $b_2 < a_1$ that we were considering in part (b). Conclude, that also with $T$ periods, the manipulator cannot expect positive profits from the simple manipulation strategy to buy at 1 and sell at $T$.

(e) Suppose that $T = 4$ and that the manipulator somehow knows (differently from the market makers) that an asset purchase in period 1 will be followed, with certainty, by two herding buyers in periods 2 and 3. The manipulator will be able to sell at $b_4 = \Pr\left(V = 1|B_1, B_2, B_3, S_4\right)$. Use the ideas from step (b) to show that $b_4 > a_1$, and conclude that manipulation is profitable under such circumstances.

## Problem 3:

Below is an excerpt of a press release from the US Department of Justice on May 16, 2011. Please write a short essay discussing to which extent the course readings can relate to the issue of this text. In particular, consider the provision of liquidity and price discovery. If you wish to elaborate your answer beyond the syllabus, you are welcome to seek more information about the current wave in stock exchange mergers.

"The NASDAQ OMX Group Inc. and IntercontinentalExchange Inc. abandoned their joint bid to acquire NYSE Euronext after the Department of Justice informed the companies that it would file an antitrust lawsuit to block the deal. The department said that the acquisition would have substantially eliminated competition for corporate stock listing services, opening and closing stock auction services, off-exchange stock trade reporting services and real-time proprietary equity data products. (...) the deal would have given NASDAQ control over NYSE's stock listings business, stock trading venues and market data licensing operations. NYSE's futures businesses, located primarily in Europe, would have been sold to the IntercontinentalExchange.

"The companies' decision to abandon their bid for NYSE Euronext eliminates the competitive concerns developed during our investigation," said Christine Varney, Assistant Attorney General in charge of the Department of Justice's Antitrust Division. "The acquisition would have removed incentives for competitive pricing, high quality of service, and innovation in

the listing, trading and data services these exchange operators provide to the investing public and to new and established companies that need access to U.S. stock markets." (. . . )

The department's investigation revealed that NYSE and NASDAQ are the only competitors in several businesses vital to the success of U.S. equity markets. NYSE and NASDAQ compete aggressively for listing customers as they are effectively the only companies providing corporate stock listing services in the United States. In order for a company to sell its stock to investors on a public exchange in the United States, the company must first "list" or register its shares with an exchange. Once listed, the company's stock can be bought or sold on any stock exchange in the United States, off-exchange at certain broker-dealers and on licensed alternative trading systems. Listing stock exchanges act as "gatekeepers" to public equity markets, allowing only certain companies that meet rigorous standards to list and attract investment capital from the public.

NYSE and NASDAQ are also the only two providers of stock auction services that are used every day at the open and close of trading, as well as at certain other times of market imbalance, the department said. At most times, the process of determining a price for a stock occurs in a robust market, with numerous buyers and sellers actively negotiating prices. However, at certain times the market cannot determine a price in this way. For example, a long line of orders builds up every night waiting to execute at the moment the market opens. These orders are based on information revealed overnight, which is not reflected in the market price at the close of the previous day. Similarly, at the end of each trading day, major market participants place large orders to balance their portfolios, potentially creating large imbalances in order flows and distorting prices, the department said. Both NYSE and NASDAQ have developed special auctions to handle these unique order flows at the open and close of each trading day.

NYSE and NASDAQ provide trade reporting facilities for the reporting of stock trades occurring outside of a stock exchange and are currently the only two entities that compete to collect this data. This reporting business is vital for the proper dissemination of information about off-exchange trading, which today accounts for roughly 30 percent of all stock trading in the United States, the department said.

NASDAQ and NYSE are the largest two competitors providing certain real-time proprietary equity data products. These products reflect, for example, the prices and quotes on the several NASDAQ and NYSE stock exchanges as well as information and data collected by the NASDAQ and NYSE trade reporting facilities for trades occurring off the stock exchanges."