# Answer Sheet to the Written Exam

# Financial Markets

April 2011

In order to achieve the maximal grade 12 for the course, the student must excel in all three problems.

## Problem 1:

This problem focuses on testing part 1 of the course's learning objectives, that the students show "The ability to readily explain and discuss key theoretical concepts and results from academic articles, as well as their interpretation." The maximal grade is given for an excellent presentation that demonstrates a high level of command of all aspects of the relevant material and containing no or only few minor weaknesses.

(a) Draw on Sections 1.1, 4.2 and 8.1 in the textbook. Dealers in the Easley and O'Hara (1987) model quote one price for an order after seeing the order's size. Market makers in Glosten (1994) post limit orders before seeing the incoming order size. Easley and O'Hara model the uniform pricing in a dealer market where an incoming trader cannot split the order over several dealers, while Glosten models the discriminatory pricing in a continuous auction.

(b) Draw on Section 5.1 in the textbook. The idea behind immediacy is a trading process whereby some traders value immediate execution without waiting for suitable conterparties (see also Section 8.2.3). The dealer offers intermediation between such traders. This implies that the dealer's inventory is not always optimal, a cost for the dealer. In Stoll's model, competitive pricing by the dealer means that he is exactly indifferent to accepting the incoming order or not. Thus pricing assets away from the market's equilibrium price, the dealer obtains a profit which precisely covers that cost.

(c) Draw on Section 6.3 and Chapter 9 in the textbook. As mentioned in many places in the book, for instance on page 47, the price impact of a trade can be taken as a measure of illiquidity. Now, equations (6.27) and (6.31) present a permanent and temporary impact of order flow on prices. As discussed after (6.31), the temporary effect represents a fixed trading cost component, while the permanent effect represents an adverse selection cost component. Equations (9.28)–(9.30) likewise decomposes an asset return into its permanent and temporary components — this is generalised in Section 9.3.3 to take into account the order flow.

## Problem 2:

This problem focuses on testing part 2 of the course's learning objectives, that the students show "The ability to carefully derive and analyze results within an advanced, mathematically specified theoretical model." The maximal grade is given for an excellent presentation that demonstrates a high level of command of all aspects of the relevant material and containing no or only few minor weaknesses.

(a) and (b) 0 is strictly preferred to 1 when the cost is lower, i.e., when $t+\lambda_0 < (1-t)+\lambda_1$, equivalent to $t < \hat{t}$ where $2\hat{t} - 1 = \lambda_1 - \lambda_0$. The left hand side is linear in $\hat{t}$, with values in $[-1, 1]$ as $\hat{t} \in [0, 1]$.

(c) We first apply the book's solution to the single-market model in Section 3.2. The desired expressions for $\lambda_i$ then follow from (3.7). A strong answer to this question will note as a concern that the risk-neutral informed trader is present in both markets. This does not affect the insider's behaviour in each market. because the objective function (expected profit) is additive Taking position $x_i$ in each market, clearing at prices $p_i(w_i)$, the realized profit is the sum $x_0(F - p_0(w_0)) + x_1(F - p_1(w_1))$.

Regarding the cost to a unit buy in market $i$, let $z_{i-}$ denote the amount of noise trade placed by other noise traders. Inspired by (3.10) we can write $E[F - p_i(w_i)] = E\left[\left(F - \bar{F} + \lambda_i w_i\right)\right] = E[\lambda_i w_i] = \lambda_i E[w_i] = \lambda_i E\left[\beta_i\left(F - \bar{F}\right) + z_{i-} + 1\right] = \lambda_i E[1] = \lambda_i$. In words, a trader's buy of one unit will systematically push up the transaction price by $\lambda_i$ unrelated to the true value of the asset.

(d) The equation follows when (c)'s expressions for the $\lambda_i$ are inserted in the equation from (b). With $\hat{t}$ solving the equation, there is an equilibrium. In each market, with a correct conjecture of the variance of noise trade, market makers and insiders behave optimally, and $\lambda_i$ results. Noise traders also behave optimally, according to our analysis in (b) and (c). Inserting $\hat{t} = 1/2$, each market is equally liquid, and the indifferent trader is placed equally far from the two markets.

(e) Both sides of the equation from (d) are upward sloping functions of $\hat{t}$ on the interval $(0, 1)$. As noted before the left hand side ranges from $-1$ to 1. The right hand side, instead, ranges from $-\infty$ to $+\infty$. We have seen in (d) that the two sides are equal at $\hat{t} = 1/2$. There is going to be three solutions when the right hand side is flatter than the left hand side at $\hat{t}$, and this happens when the leading coefficient $\sigma_F/\sigma_z$ is small.

It is an equilibrium, that all traders go to the same exhange. It follows from (c) that the other exchange is infinitely illiquid, offering infinte costs of trade to noise traders. From (a) and (b), no trader will visit the infinitely illiquid exchange — instead, all prefer the exchange where everyone else goes.

In general, when the noise traders do not split evenly among the two exchanges, the one visited by the majority becomes more liquid and offers lower transactions costs. This result is familiar from Chapter 10, and explains why the liquid exchange is preferred by trader $t = 1/2$ being equally far from the two exchanges. When we have $\hat{t} \in (0, 1)$ with $\hat{t} \neq 1/2$, the liquidity difference is moderate, and traders sufficiently close to the illiquid exchange choose it to save on transportation costs.

# Problem 3:

This problem focuses on testing part 3 of the course's learning objectives, that the students show "The ability to apply the most relevant theoretical apparatus to analyze a given, new case-based problem." The maximal grade is given for an excellent presentation that demonstrates a high level of command of all aspects of the relevant material and containing no or only few minor weaknesses.

Below are some suggested applications of the course literature to this case. It is important to note that these applications have shortcomings which should be discussed.

- We learn that the market has grown more volatile with some investors fleeing. This tends to drive down prices (higher yield). The lower price may reflect a greater risk premium (Section 2.2). But the absence of some potential asset holders from the market may also give rise to a higher liquidity premium (Section 7.1).
- Section 2.2 also suggests that a greater supply of a risky asset will reduce its price.
- There is a lack of transpareny, and greater uncertainty about the meaning of credit ratings. The last section of the text also points in this direction. Such effects suggest that there could be greater overall uncertainty than before. But they also create the more opaque setting where asymmetric information about cities may play a greater role. Stylized features of our theoretical models have suggested that greater asymmetric information may reduce liquidity. For instance, Kyle's $\lambda$ of equation (3.7) is greater with greater information asymmetry measured by $\sigma_F$. Again, greater illiquidity could imply a greater liquidity premium.