

Experiment Instructions (CDA)

Welcome, and thank you for participating!

From now until the end of the experiment, please do not communicate with other participants. If you have any questions, please raise your hand; an experimenter will come and answer your question. Please pay careful attention to the instructions as real money is at stake.

During the experiment you will earn *Experimental Currency Units* (ECUs) and at the end of the experiment all your earnings will be converted to US dollars at the rate of one dollar for every two ECUs. You are guaranteed a show up fee of \$7.00 but can earn considerably more.

Basic Ideas

In this experiment you will participate in a simple **automated financial market**. Using information displayed on your screen as in Figure 1, you will **set and adjust trading algorithms (bots)** so as to earn as many ECUs as you can. As explained below, your earnings will depend on the settings you choose and on the choices of **the other five participants** in your group. There will be **eight trading periods**, each lasting **four minutes**, after which the experiment will end and you will be paid.

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Figure 1

Stock value. There is just one stock traded in your financial market. The stock has a *value* (henceforth “*V*”) that will jump up or down by a random amount at random times. The average time between jumps is about 1 second, but shorter or much longer times are possible. The Choice Box on your screen will always center on the current value of *V*, depicted by a horizontal gray line (see Figure 1). Every time there is a jump in *V*, there will be a yellow flash around the center line, and all other prices (described below) will appear to shift until they adjust to the new value of *V*.

Buy Orders, Sell Orders, and Spreads. All participants control algorithms (bots) that submit *buy orders* and *sell orders*. Submitting a *buy order for 99*, for example, means that you are willing to pay 99 ECUs or less to buy a share of the stock. Similarly, if you submit a *sell order for 101*, you are willing to receive 101 ECUs or more to sell a share of the stock. The price difference between your buy and sell orders is referred to as your *spread*. In the 99/101 example, your spread is 2.

Investor arrivals. At random times an automated investor arrives in the market to buy a share of the stock at the best available (lowest) selling price or to sell at the best available (highest) buying price. In today’s experiment, the average time between investor arrivals is about 2 seconds, but again shorter or much longer times are possible.

Your Choices and Earnings

Participants choose among three possible roles: *maker*, *sniper* and *out*. You can change your role at any time of the trading period, using the buttons on the right side of the *choice box* (see GIF 1a).

Maker. As a maker, you post both a buy order below V and a sell order above V using the computer program (henceforth, “your bot”) shown in GIF 1b. These orders are symmetrically located around V and are represented by the horizontal blue marks above and below the center line representing V . Your spread is the green or blue shaded region between those marks. To adjust your orders (and spread), simply click at the desired point in the choice box (see GIF 1b). Your bot will cancel your old buy and sell orders and send new orders to the market with the spread that you just chose. Since it takes time for the new orders to travel to the market (as explained below), your new orders are initially represented as horizontal lines at the right side of the choice box which slide toward the center of the box, at which time they replace the old orders.

You make a profit when an investor randomly arrives to buy if you are the maker with the lowest sell order (best price). Your bot automatically sells at your posted price and buys a replacement unit at the asset value V , so your profit is the vertical distance between the sell order and V . Similarly, you also make a profit when an investor randomly arrives to sell and you are the maker with the highest buy order (best price). Your bot will automatically buy at your posted price and sell it at the value V , so your profit is the difference between the value V and your buy order (see GIF 1c). Profits from transactions are represented by flashing green lines between V and the corresponding buy or sell order in the choice box, and are also displayed as vertical green lines in the profit box.

You can also lose money (earn a negative profit) while in the maker role. When V jumps up or down, your bot cancels your buy and sell orders and sends new orders to the market with prices that are centered on the new value of V . However, it takes time for your bot to send the orders and get them processed, and during that time you may be “sniped” by another participant. For example, suppose again that $V = 100$ and your current spread is 2. If V jumps to 105, your bot will send messages to the market cancelling your 99/101 orders and placing new buy and sell orders at 104 and 106. (In the choice box, you will see the blue marks representing your orders, and the shading between them, jump down relative to V . The blue marks and shaded box will then jump back to their original positions when your bot’s new orders are received, a fraction of a second later.) Before the new orders are processed, you are still committed to sell for 101 (cheap!) despite the fact the value of the asset is 105 -- we say that your orders are “stale”. You will be sniped if anyone places a buy order before your orders update. In this example, sniping would result in a loss of $105 - 101 = 4$ -- you sold too cheap. (see GIF 2b). Whenever you are sniped, the loss is the vertical distance between V and your old sell order. Similarly, if V jumps down, your stale buy order is vulnerable to being sniped. Losses from snipes are represented by flashing red lines between V and the corresponding buy or sell order in the choice box, and are likewise displayed as vertical red lines in the profit diagram.

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GIF 1a Role Choice	GIF 1b Change Own Spread	GIF 1c Investor Arrival

Sniper. If you choose to be a sniper, you attempt to transact with stale orders of makers. Whenever there is a jump event (yellow flash), your bot will send an order that tries to buy at a mispriced sell order (for an up jump in V) or sell to a mispriced buy order (for a down jump). As with maker orders, it takes time for sniper orders to reach the market. If your order is processed by the market before the stale orders are updated, you will transact and your choice box will flash green to indicate your profit (see GIF 2c).

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GIF 2a Value Change	GIF 2b Value Change, Getting Sniped	GIF 2c Value Change, Sniping

Out. If you choose to be out, you do not participate in the market. In this role you never earn profits nor take losses.

Choosing Speed. As a *maker* or a *sniper*, it takes time to send your orders to the market. At **normal speed** (the default option) it takes half of a second to update orders. Alternatively, you can choose **fast speed** to reduce the update time to one tenth of a second, but it costs 0.02 ECUs per second for the faster service. You can activate or deactivate the speed option at any time. For example, if you activate speed now and deactivate it 30 seconds later, you are charged 0.60 ECUs, as you will see in the Profit Box. Choosing speed reduces the chance that a maker will get sniped and increases the chance that a sniper will be successful.

Tie Breaking. Whenever more than one sniper or maker is trying to update orders at the same time, the exchange will break ties randomly and execute the orders one at a time.

Trading Period Payoffs. You begin each *trading period* with an endowment of 20 ECUs. Gains and losses from the trading period will be added to and subtracted from your endowment to form your profits for the period.

Interim Screens. In between trading periods, your screen will display a summary of role and strategy choices as well as profits made in the last period (See Figure 3). On the left side of the screen, you will see the average profits per minute of a player with certain strategy. For example, there will be a bar indicating the profit per minute of choosing the role of a Maker with the lowest spread and with speed ON, another bar indicating the profit per minute of choosing the role of a Maker with the lowest spread and with speed OFF, and so on. On the right side of the screen, you will see a pie chart that summarizes the frequency of the main role and speed choices in the last period. For example, if the

Maker-Fast strategy makes up 20% of the pie, it means that, on average (during the whole duration of the trading period), 20% of players chose the role of a Maker and had speed switched to ON.

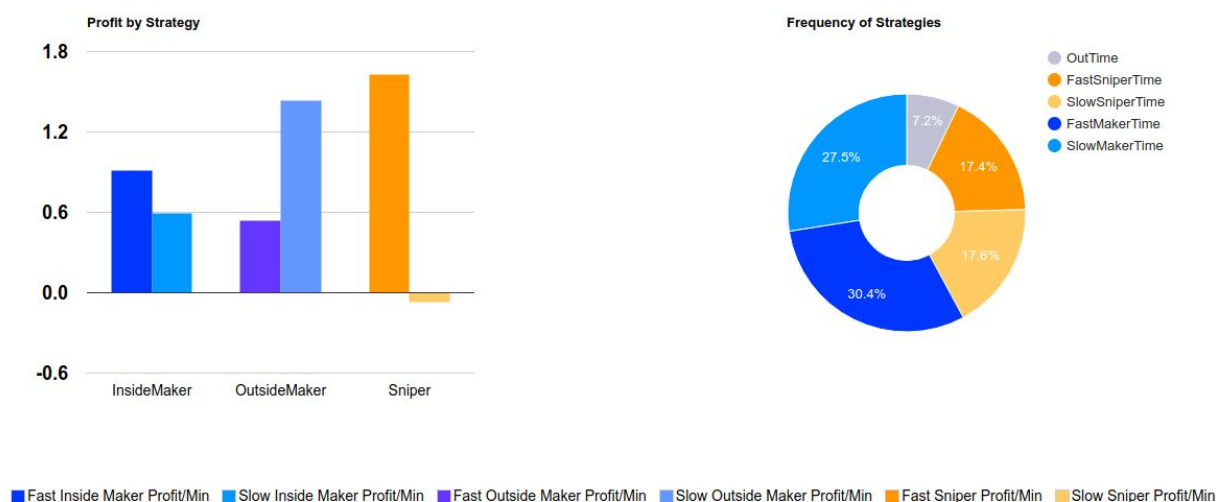


Figure 3: Interim Screens

Session Earnings. Your final earnings for the session will be the sum of your show up fee (\$7.00) and the profits of one randomly chosen trading period, converted into US dollars.

FAQs.

Q1. Do I face the same five participants every period, or do they change?

A1. Yes, it is always the same five, chosen randomly at the beginning of the session.

Q2. If some other market maker has a narrower spread than mine, can I make money?

A2. No. When an investor arrives, only the maker with narrowest spread gets to trade. Other makers never get to trade profitably. (They will trade unprofitably if they get sniped, which can happen occasionally.)

Q3. Is this experiment a test of how fast I can react?

A3. No. The competition is intended to focus on which role to pick, whether to invest in speed and (if a market maker) what spread to choose. Since there is no way to predict the exact time of investor arrivals or jumps in V , **what matters is your average choice**, not how fast you react.