

Background to:

TraderEx Self-Paced Tutorial and Case



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Securities Trading

Trading in financial markets involves the conversion of an investment decision into a desired portfolio position. It is the final stage of the asset management process, and is a treacherous part where all of a manager's best efforts in selecting an investment can be surrendered by incurring excessive trading costs or delays. Trading is not investing, and traders' decisions differ from investors' decisions. Portfolio managers focus on stock selection, and take account of the risk and return characteristics of different securities. Traders implement the PM's decisions, handling buy and sell orders carefully to achieve "best execution."

Traders bring the orders they are given to the market, interact with other traders and, in the process, focus on liquidity (or the lack thereof). Once an investment decision has been passed to the trading desk, time acquires a different meaning. The clock suddenly accelerates. Prices in the marketplace can move sharply in brief intervals of time. As they do, trading opportunities pop up and quickly vanish. Your own order handling can cause a price to move away from you. Poor order placement and imperfect order timing are costly. A hefty portion of the gains that a portfolio manager might otherwise have realized from a good investment decision can be eroded by poor trading decisions.

Investing vs. Trading

Investors want their trading to be completed at the least possible cost and in a timely fashion. Trading is also about assessing the limited liquidity in a market, finding pricing discrepancies, and entering the appropriate buy and sell orders to realize profits from market imperfections.

The field of *market microstructure* details how markets operate, and provides measures of market quality, including how well the market discovers prices and handles stressful conditions (e.g., important news announcements, or economic shocks). Understanding a market's structure and the features it offers can improve trading decision-making.

Financial markets have been transformed by technology and regulatory change in the past 30 years (Figure 1).

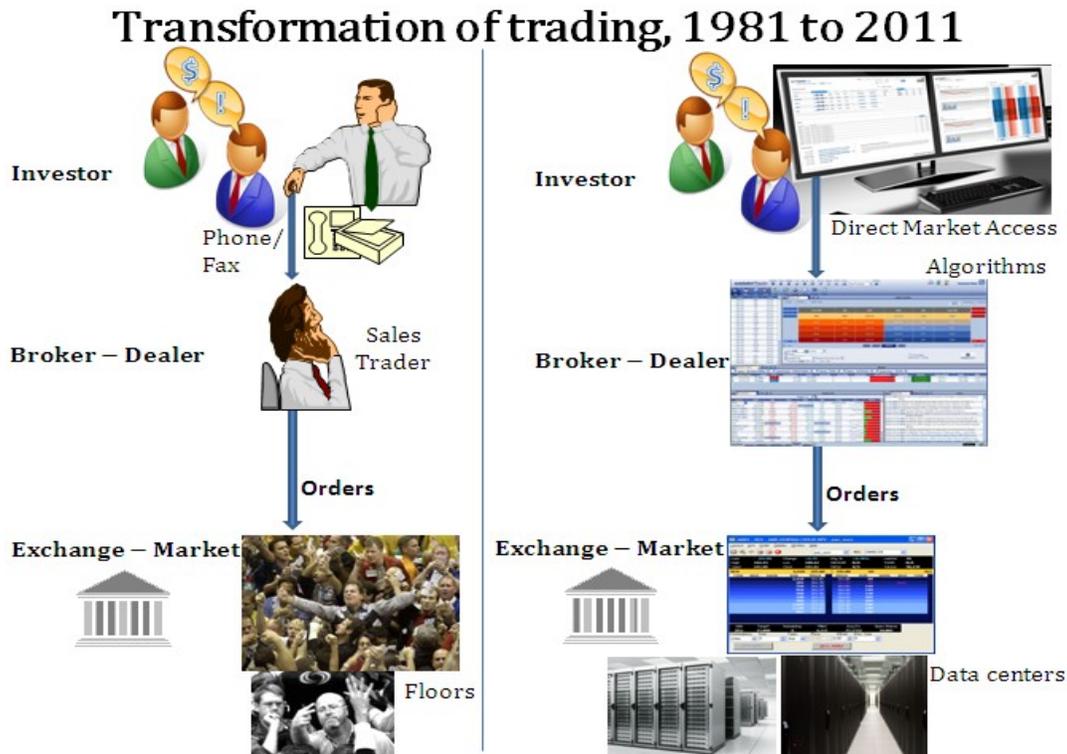


Figure 1: Changing market technology

Today, investors still manage pools of assets, but voice communication and paper trade tickets have been replaced by electronic messaging and real-time position tracking. Sales traders, who once mediated between clients and floor traders have been replaced by order management systems and trading algorithms. Markets, once floor-based, are now housed in large data centers with low-latency network connections to traders around the world.

The TraderEx Trading Simulation

Trading simulations enable you to gain experience making trading decisions without risking actual money. TraderEx provides a market structure, which is the set of rules for matching buy and sell orders to create trades, and generates a stream of orders. To be realistic and engaging, a trading simulation must have four properties:

The machine-generated order flow must capture the pricing dynamics of a real-world marketplace.

The simulated market must give you some basis for anticipating future price movements.

The software must enable you to replay a simulation run so that you can see the effect of a change of your strategy, or of the market structure, or of the parameter settings (e.g., volatility, order arrival rate)

The simulation must provide you with meaningful performance benchmarks to compare with others and to know whether you are improving with experience.

Capturing the pricing dynamics of a real marketplace requires that quotes and transaction prices in the simulated environment do not follow pure random walks, and the returns traced out as the simulation progresses reflect an intricate correlation pattern that is attributable to the way in which the orders are handled (e.g., entered into a limit order book) and turned into trades (e.g., the arrival of a market order triggers the execution of a limit order). Replaying “canned data” from prior periods in a market fails to capture the fact that your orders impact the market. Therefore, TraderEx generates its own dynamics and enables you to affect the course of trades in a simulation.

Forces that Drive Trading

TraderEx’s machine generated order flow is based on draws from various statistical distributions. Underlying the statistical events and changes in the stock’s fundamental value (P^*) are economic stories that pertain to the three classes of traders:

Informed traders: they are motivated to trade by the arrival of nonpublic news, and evidence of market prices greater or less than P^*

Liquidity traders: they are motivated by the individual cash flow needs of the different participants

Technical traders: they are motivated by their beliefs that they have observed exploitable patterns in the stock’s price movements

The arrival rates for orders and events can be modeled as a statistical process. The arrival of information driven and liquidity driven orders is modeled with the use of a stochastic process known as the Poisson Arrival Process. The Poisson process has the interesting property of being memoryless, which means that, no matter how much time has passed since the last event, the probability that P^* will jump again in the next segment of time (e.g., the next 10 minutes) remains constant. Consequently, it is not possible to predict when P^* will next change based on the amount of time that has passed since it last changed.

Changes to the P^* Fundamental Value

The magnitude of information change, when it occurs, is reflected in the size of the jump in fundamental value, P^* . Each change in P^* is an investment return to holders of the stock. P^*

jumping up (a positive return) means that the stock has a greater value, while P^* dropping down (a negative return) is bad news for holders of the stock. In our TraderEx simulation, the P^* returns are lognormally distributed with a mean of zero as the default setting.

Over any simulation run, P^* may drift up or it may drift down but, with a mean return of zero, there is no systematic tendency for it to move in one direction or the other over any simulation run. We can change the magnitude of the information events, and thus the underlying level of market volatility, by changing the variance parameter of the lognormal returns distribution. Because the P^* returns are obtained by random draw, successive changes in P^* are not serially correlated. P^* moves randomly through time. In other words, our equilibrium price follows a random walk.

For some exercises, we have pre-configured P^* and a set of news stories. A news release itself could give you an expectation about the P^* change. If you respond accurately and quickly, you may get your trades done before the new information is fully incorporated in share price.

How Market Prices adjust to P^*

Operationally, when P^* is above the offer (or below the bid), the arrival rate of market orders to buy (or to sell) is increased from 50 percent to 70 percent of the total order flow. When P^* is below the bid, there will be $7/3$, or 2.33 sell orders for every buy order, on average. Similarly, when P^* is above the offer, there will be $7/3$, or 2.33 buy orders for every sell order on average. When P^* is between the bid and the offer, no informed orders are generated and market orders to buy and to sell arrive with equal probability.

Informed orders are perfectly directionally correlated with each other. If one informationally motivated order to buy arrives at the market, another will also arrive, and then a third, and a fourth, and so on until the market ask is pushed above P^* . Of course, due to the random arrival of other orders, some sell orders will be intermingled with the informed buys. Similarly, if one informationally motivated sell order arrives, other similarly motivated sell orders will also come in (most likely laced with some buys) until the market bid is pushed below P^* . This is in contrast with our second type of machine generated orders – the liquidity -motivated orders. The liquidity orders are uncorrelated with each other. In the next section, you will see how the liquidity motivated orders are generated by TraderEx.

The liquidity orders in TraderEx are equally likely to be buy orders or sell orders, and the assignment for each newly-generated liquidity order is done randomly and independently. Whatever motivates them, the important thing for us is that these orders are uncorrelated with each other. Recognizing this, the “liquidity motive” that we discussed in Chapter 1 can be expanded to include all reasons that are unique to an individual. Most importantly, let’s include a trader’s own, individual reassessment of share value. Each investor, having his or her own

opinion about a security's value, is free to change that opinion for a reason that only he or she knows.

Accordingly, a better term for "liquidity motive" may be idiosyncratic motive. But we will stick with the former. "Liquidity motive" is widely used (and also it is easier to say). In the TraderEx simulation, liquidity orders may be either limit orders or market orders, whereas, with our standard treatment of P^* , informed orders are always market orders. Informed traders are impatient because they know that the market will soon adjust and erode their profit opportunities. The informed traders arrive only when P^* is not within the market quotes, but liquidity traders can arrive at any time. For each liquidity order, its time of arrival, size, type (limit or market), and price are determined by random draws from the relevant distributions.

TraderEx incorporates a kind of technical trader, a momentum player. Momentum trading is an essential component of TraderEx. Without uninformed momentum traders, it would be too easy for you to detect P^* shifts from the evolution of trade prices. This is because any jump in P^* that puts it above the offer (or below the bid), triggers a preponderance of machine-generated market orders to buy (or market orders to sell), and these market orders cause prices to run up (or to run down) toward the new value of P^* . This pattern must be obscured in some way, or you could profit too easily by buying or selling whenever price appears to be trending up or down. We do not want you to be a monopolist with respect to this strategy, and momentum trading is the answer. Momentum trading can compete with you if you try to jump on a trend by buying when the quotes rise, or selling when they fall.

Trends can be misleading. The momentum-driven orders raises uncertainty for you by reinforcing false, unsustainable price moves. Price can trend up due to several liquidity motivated buy orders arriving by chance. Economically, the overshooting caused by momentum orders provides compensation that is necessary for limit orders to be submitted. A relatively wide bid-ask spread also provides further compensation. Accordingly, when you are formulating your trading strategy in the TraderEx order driven environment, pay attention to the price swings and to any relative sparseness of the book, for both can make limit order submission a profitable trading strategy for you to employ.

Setting Up a TraderEx Simulation

The configuration screen in allows you to customize the market conditions and the specific properties of the underlying equity. This section explains how to do this.

The screenshot shows the 'TRADER-EX SETUP CONFIGURATIONS' window. It is organized into several panels:

- Market Structure:**
 - Primary Structure:** Order Driven, Dealer
 - Alternative Structure:** Call Auction, Block Trading, Crossing Network, None
- Configuration:**
 - Information arrives every: 2 hours
 - Orders arrive every: 4.0 minute(s)
 - Daily Return Volatility: 6 %
 - Simulation will run: 1 day(s)
 - Time Interval: Daily
 - E(Return in Interval): 8 %
 - Volatility(Return) in Interval: 8 %
 - Limit Order Percentage to: 70.0 %
 - Initial Price: 20
 - Start Time: 9:30 am
 - End Time: 4:00 pm
 - Select Tick Size: 0.1
 - Target Order Generation: 0 % of tot vol
 - Initial Cash: 0
- Enter the Scenario Number:** [Dropdown menu]
- Select Role:** Live Trader, Algo Trader, Live Dealer
- Informed Order Generation:** Standard, Endogenous, Only Informed Orders
- Dealer Configurations:**
 - Dealer's Initial Spread: 10 Tick(s)
 - Cases: Strict Price Priority, Some Preferencing
- Auction Trading Configurations:**
 - Opening Call, Midday Call, Closing Call
 - Execution Priority: Price/Time, Time
 - Visibility: Transparent, Opaque
- Block Trading Configurations:**
 - Trade Through Allowed
 - Orders arrive every: 35 minute(s)
 - Limit Order Percentage to: 70.0 %
- Crossing Network Configurations:**
 - Crossings occur every: 30 min
 - Orders arrive every: 6 minute(s)
 - Opening Crossing at: 10:00

A 'SUBMIT' button is located at the bottom center of the window.

A setup configuration screen allows you to choose the market structure. We will focus on the Order Driven market design. Several other settings are

Enter the scenario number - a random number seed which that will allow you to replay a simulation holding everything constant except your own interaction with the system, or any other parameter or market structure feature that you might wish to change at the start of the next simulation run.

Select Information Arrival: This parameter sets the expected number of P^* changes throughout the trading day. The default setting is for a change in P^* to occur every two hours on expectation.

Select Order Arrival: This parameter sets the expected arrival rate of orders that are generated by the computer. For a relatively liquid, big cap stock, this setting might be one or two minutes. For a relatively illiquid, small cap stock, this setting can be 6 minutes or more.

Select Volatility: The volatility parameter is the variance of the (log normal) returns distribution used to get new values for the underlying equilibrium price, P^* . For a relatively low volatility stock, this setting can be 1% percent or 2% percent, while for a relatively high volatility stock it can be set closer to 10% percent (or more, if you wish). The information arrival setting and the volatility parameter work together to

form the price pattern. For example, if you set the information arrival to 2 (the default setting), you will have a change in P^* every 2 hours (on average), which will produce (on average) three changes to P^* per trading day. By setting the intraday volatility (which is dimensioned as a standard deviation) to 6% percent, changes to P^* will be 2% percent (on average). Providing you with an average of three P^* changes, each of which on average is 2% percent, results in an intraday volatility of 6% percent.

Select Days: Multiple-day simulations can be run. If you choose multiple days, you will have to be prompted to skip to the next day by clicking the Fast Forward (“FF”) button on the control panel.

Select Time Interval: For multiple day simulations, this represents the amount of time between successive days. For example, if you wanted to simulate four trading days evenly spread over a year, the time interval would be quarterly.

Select Expected Return in Interval: The expected return is set for the given time interval set above. If the time interval selected above is quarterly, this is the three-month expected return of the stock.

Select Volatility of Returns in Interval: This is the volatility of the expected return of P^* for the given time interval.

Select Limit Order Percentage: An incoming liquidity trade order can be a market or a limit order. The limit order parameter sets the percentage of liquidity orders that come into the system as limit orders. If you wish to work with a relatively liquid order book, this parameter should be relatively high. The lower the setting, the less liquidity will be in the order book. The default setting is 70% percent.

Select Initial Price: This is the opening price.

Select Start time: Daily start time for the simulation. The default start time is 9:30 A.M.

Select End time: Daily end time for the simulation. The default end time is 4:00 P.M.

Select Tick size: You can choose the minimum price variation. The default setting is 10¢.

Select Target Order Generation: The computer can automatically generate a target position to obtain at the end. This simulates the role of an equity trader. The pace and risk will be based on the target, which is based on a percentage of the total trading volume. The initial position target (a number of shares) is delivered to the participant at the start of the simulation

Set Initial Cash: The computer can start you with an initial amount of cash.

The Order Book market will described and demonstrated next.

The Continuous Order Book Market

The TraderEx software maintains a limit order book that enforces strict price and time priority. In other words, the limit orders to buy (sell) at the highest (lowest) prices trade first and, at the same price, the order that arrived earliest trades first. All orders sent to the order book are sized in terms of units where 1 unit is 100 shares. An order for 55 can be thought of as an order for 5,500 shares. This saves us from displaying numerous zeroes on the screen. With the order book, you can do the following:

- Buy shares immediately with a market order. You will execute against the sell limit orders (OFFER) that others have entered into the book. The lowest priced offers will execute first.
- Attempt to buy shares by placing your own limit buy orders (BID) and hoping that they execute against incoming sell orders.
- Sell shares immediately with a market order. You will execute against the buy limit orders (BID) that others have entered into the book. The highest priced bids will trade first.
- Attempt to sell shares by placing your own limit sell orders (OFFER) and hoping that they execute against incoming buy orders.

The figure below illustrates the order book in the Stand-Alone version of TraderEx.



Figure 2: Order Book: The TraderEx Screen

The first row of the simulation screen shows:

Day and time	How far you are into the simulation
Scenario	Scenario number (each one has a different P* path)
Trades	Total number of trades completed

The next three rows show a scrolling ticker of the most recent trades with prices, sizes, and trade times. Below the ticker is a display of the day's trading volume, high and low prices, and volume-weighted average price (VWAP).

All TraderEx limit orders are displayed. Note that some real markets have hidden or iceberg orders that are not displayed.

At the bottom of the screen is the total number of shares in your net position and your average price to acquire that position. In Figure 2, the user is long 31 units of the stock, which were bought at an average cost of 20.06. From this data we see that to make a profit, he or she must sell the stock at a price greater than 20.06 to realize a profit.

There are five in-game chart graphs available by clicking on the tabs shown in Figure 2. The charts can display the changes over time of the following measures:

- Market Bid/Offer quotes
- Average Cost vs. VWAP
- Total Average Buying/ Selling vs. VWAP

- Average Position
- Risk (are you within a range around your target position)

Performance Measures and Statistics

There are several performance measures in TraderEx. As shown in Figure 2, they include:

- Net Position: Current net position in units.
- Avg. Cost: This is the price per share of your current position.
- Cash: Amount can be positive or negative
- Realized P & L: the profit (loss) that you have captured throughout the day from shares that were bought and then sold (or sold and then bought back).
- Unrealized P&L: the current inventory of shares marked to market. The standard principle is to mark long positions to the bid quote and short positions to the ask quote
- Avg. Buy Price (Score): This is the Average Buying Price—, this is the average price paid for all shares purchased
- Avg. Sell Price (Score): This is the Average Selling Price—, this is the average price received for all shares sold.

Under the RISK Tab:

- Target position is what you are expected to have at the end of the end of the simulation. The default is zero. You can edit the target amount by clicking on the word «Target» and entering the desired target.
- To Go is the number of shares to reach your target. The Pace amount is the position you would have if you executed the order at a constant rate.
- The (min) and (max) values represent the allowable deviations from the target line. Any position outside this range will result in an accumulation of risk.
- Avg Pos: This is the average position the trader had throughout the trading day.

More Stats Tab:

- My Vol (% Market Share): This is your total volume and your volume relative to the market's total volume. The market's total volume is the number of shares traded.

- Mkt Order Vol: Volume of stock you have acquired through market orders.
- Lmt Order Vol: Volume of stock you have acquired through limit orders.
- Total Vol: The total number of shares you have traded. . If you buy 10 units and then sell 10 units, your net position is zero and your total volume is 20 units.
- Trades: Total number of trades you were involved in.

In all of the TraderEx market structures, the clock for the market day in TraderEx can be advanced by the user with time effectively stopped between market events. Alternatively, time can progress continuously under the control of the computer at a slow, medium, or fast rate. There are three arrow buttons and one “GO” button to adjust the advance of time

Entering a Market Order

To submit a market order, type in the quantity you wish to buy or to sell in one of the boxes at the top of the book. As we have noted, quantity is measured in units, where a unit is 100 shares. Let us enter a 20-unit order (2,000 shares) to buy at market. Do this by entering 20 in the white box to the right of the label “BUY” (just above the limit order book) and hitting “Enter” or by clicking the “BUY” button. This will result in your buying 20 units at the lowest posted offer on the book.

If your market order is for a number of units equal to or less than the volume at the posted quote, your order will execute completely at that price level. Market orders that are larger than the quantity at the best bid and ask quotes will “walk the book” to the next price level(s). That is, if your order is for a larger number of units, it will execute at successively inferior prices until it is completely filled.

Entering a Limit Order

You can enter a limit order into the order book by clicking on the box next to the price limit that you want your order placed at. Once you have entered an order, it will be visible in the book. In the left of the screen shown below, you will see the buy limit order placed in the book at \$20.00. The size of your order is 30 units. Turn to the screen on the right, which applies after you have entered your order. As indicated in parentheses, 0 units to buy from other traders have time priority over you, and thus your order will be the first to execute if a market order to sell arrives. Because there are no other orders at the price, the total bid quantity at \$20.00 is 30. This is shown in Figure 3.20.

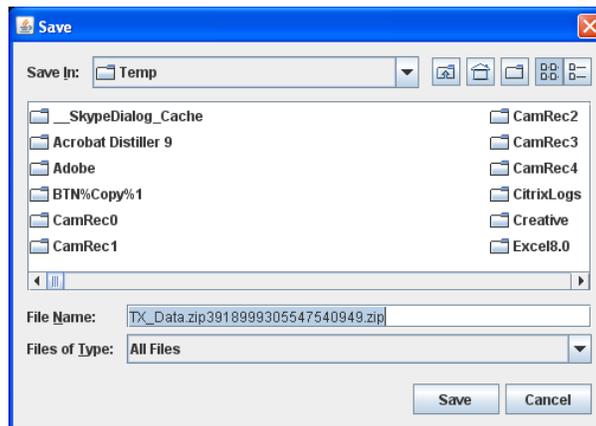
Limit orders can be made larger by clicking on the existing order and adding a new amount to it. To cancel a limit order that you have previously placed, click the red “X” next to it.

Navigating the Order Book

As prices move throughout the trading day, it might be necessary to change the view of the order book. By using the navigation button on top of the order book you can adjust the price levels seen in the order book. Clicking the “UP” button will display higher prices in the order book. Alternatively, clicking the “DOWN” button will shift the book down, displaying lower prices. You can also click the “CENTER” button to center the order book prices on the best bid and offer.

Saving Your Simulation Results

At the end of each TraderEx simulation run, the final trading data can be captured to document your performance. By clicking on the “GET DATA” button from the simulation you will generate a zip file and a dialog box appears, shown below.



Included in the zip package is a file contains trades that occurred in the simulation. The file can be opened in Excel. The rows that have the SellerID or BuyerID equal to 10 are the trades of the user.