

GO IT! Academy Data Science Program – Use Case

Template Description

Author

Group 2

Title

Trade the Opening

Elevator pitch

Finding trading strategies that work is almost as the quest for the holy grail. However, markets often show patterns of inefficiency which are not easily be convertible into profit because of costs involved. As market maker on many exchanges we follow and trade the stocks throughout the day. So an additional strategy which is looking on opening and closing auctions does not bring much of an extra effort. And yes, there are patterns.

Problem description

We will analyze the opening gap of stocks and their behaviour during the trading day, especially the intra day performance until the closing auction.

- The most simple approach will look at the opening performance $r_t^O := \ln(O_t/C_{t-1})$ and have a look what has happened then during the day – comparing it to the intraday performance $r_t^C := \ln(C_t/O_t)$.
- Maybe we have to add some additional information to enrich this rather simple approach:
 - threshold levels where we might find different behaviour of the opening to closing performance
 - additional indicators as moving averages of the time series to show a trending behaviour
 - add stop losses and maybe also stop limits to take some of the profits

Relevancy to banking areas

We already have a framework for (semi) automated algorithmic trading strategies, but we are constantly working on finding new ones, and improving the existing. Additionally we are also keen to improve our market share in daily trading turnovers in stocks we are market making. So there are many good reasons to create additional trades.

Data

- We will use free available data
- As an underlying pool we will analyze the ATX, DAX and if data is available also WIG20 members.
- Daily Open, High, Low, Close values are being taken into account

Detailed Description of the Strategy

We will now introduce the use case in more detail. First we will have a look at the exchanges in more detail to understand the upcoming trading logic.

The Exchanges

Xetra Vienna and **Xetra Frankfurt** have both the same system (T7) up and running so we will only describe the whole trading day once because they both inherit apart from the exact time tables the same procedures and price logics throughout the day.

WSE Warsaw has a different system running, but we will see that the logic is not different in the main points.

Xetra T7:

Xetra has three different trading procedures:

- Continuous Trading with Auctions
- Auction
- Continuous Auction

We will only cover underlyings following the first approach, which is the standard model for these exchanges.

The whole trading day for underlyings under continuous trading with auctions is perfectly described in section 4 under 4.1. (-> xetra-vienna-t7-detailed-specifications-market-models.pdf), or the version for Frankfurt under section 8.1.ff. (-> Xetra-FFM-T7_Market_Model.pdf).

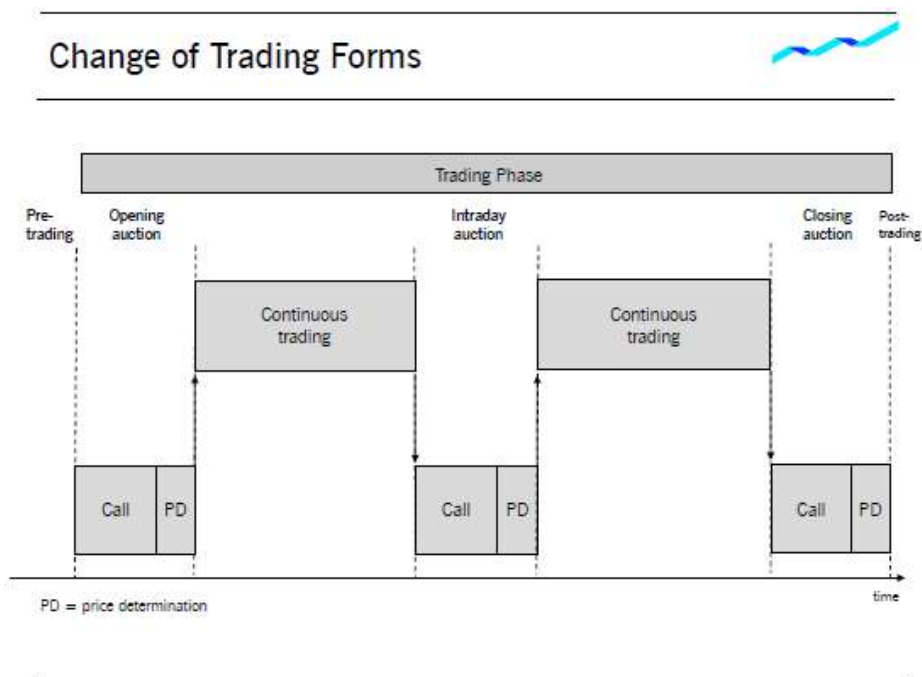


Figure 1: Change of trading forms

What can be seen here, is that the trading day is split in different stages or phases. Loosely speaking, the day begins with the opening auction, then we have a transition into continuous trading and at the end of day we have the closing auction. We intentionally have left out the mid day auction because it won't be used in our setup, so it will be part from the intraday phase in our model.

The opening auction

The opening auction separates the pre-trading phase from the continuous trading phase which takes the largest part of the intraday trading. Intraday trading in continuous trading phase is only disrupted by volatility interruptions (see section 9 in Xetra-FFM-T7 for more details) when there are huge price movements in both the current price or also the indicative price at the end of auctions (see 9.2.2 in Xetra-FFM-T7).

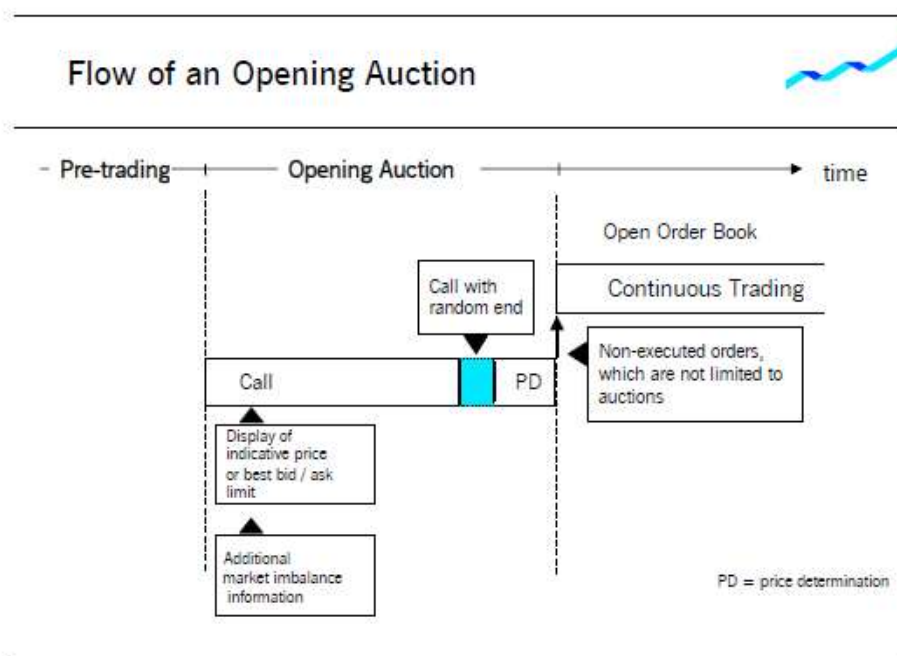


Figure 2: Flow of an opening auction

Orders from the previous day which were set with a validity time longer than the last day (see section 5.42 in Xetra-FFM-T7) will be put into the books again. Thus the price won't change as no new orders are being placed.

Then the call phase at a fixed time takes place. New orders might now be added to the order books. Information on the current order situation is provided continuously during the call phase in which the order book remains partially closed. The indicative auction price is displayed when orders are executable. This is the price that would be realized if the price determination was concluded at this time. If an indicative price cannot be determined, the best bid/ask limit is displayed. The indicative price cannot be determined if there is no overlap of buy and sell orders. So no transaction would happen at the end of the auction.

The call phase is followed by the price determination phase. The auction price is determined according to the principle of most executable volume on the basis of the order book situation at the end of the call phase. The auction price is the price with the most executable volume and the lowest surplus in the order book.

The call phase has a random end after a minimum period in order to avoid price manipulation. After the random end we have then the price determination process which will end up in the opening price of the underlying or in special cases a volatility interruption as mentioned above.

Intraday trading

Continuous trading is started after the termination of the opening auction. During continuous trading the order book is open, thus displaying the limits and the individual order volumes (depending on the market data interface instead of each single order the accumulated order volumes of each limit and the number of orders in the book at each limit might be displayed). Each new order is immediately checked for execution against orders on the other side of the order book.

The closing auction

Continuous trading is followed by the closing auction. The closing auction is also divided into call phase and price determination.

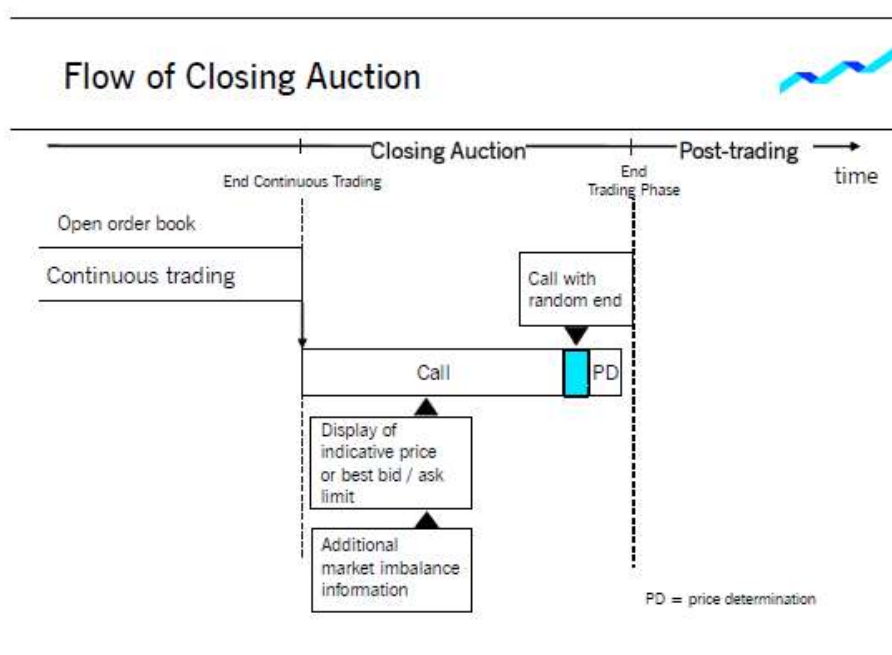


Figure 4: Flow of Closing Auction

In the closing auction, all available orders are concentrated in one order book. This applies to orders and quotes taken over from continuous trading as well as to orders, which have the trading restrictions "auction only" or "closing auction only" or are only entered in the order book during the closing auction. This means one can place an order already during the day and the order will only be added to the order book once the trading phase switches to the state closing auction. We will also use this feature later on in our trading setup.

The Strategy

Motivation

Let's have a look at the Raiffeisenbank International chart of some trading days in the most recent past. What can be easily seen is that there are opening gaps in both directions of different size followed by an intraday move not always confirming the gap's direction.



We assume that we can find a strategy for entering a position during the opening auction and closing the position in the closing auction with a profit. The assumption is that a prediction of the intraday performance can be made given the information up to now including the indicative price during the opening auction.

We assume that the opening price will be the indicative price close to the end of auction phase. So we need to define the indicative auction price during the opening auction being a price process which will have a random end. Meaning we know the price at a certain time point, but the price might still change.

We define the indicative opening price process IOP_s^t for $s \in [0, T + \varepsilon]$ being the time span from the beginning of the opening call phase till the end time point of the auction per exchange definition T plus the random end ε of the auction on that day t (in Xetra T7 this is a random number between 0 and 30 seconds). We assume that the log price change during the random end is also normally distributed with mean 0, so we have

$$\hat{O}_t = \mathbb{E}(O_t) = IOP_T^t$$

The Model

The gap is defined as followed:

$$r_t^O := \ln(O_t/C_{t-1})$$

Which is the log return of the opening price O_t over the previous closing price C_{t-1} . The second variable we are interested in is the intraday performance

$$r_t^C := \ln(C_t/O_t)$$

Additional input factors which are available are the intraday high H_t and low L_t , which are the highest resp. lowest price traded that day. We will also use intraday normalized values compared to the log performance against the respective opening: $H_t^{lo} := \ln(H_t/O_t)$ and $L_t^{log} := \ln(L_t/O_t)$.

Also trend indicators as moving averages might be used as additional factors:

$$SMA_t^N(UL) := \frac{1}{N} \sum_{k=0}^{N-1} C_{t-k}^{UL}$$

The simple moving average is just the average closing price of the respective time horizon. We will use a SMA^{50} and SMA^{200} indicator as additional information. As the trends indication is determined if the current price is above or below the moving average, we might also define normalized indicators as

$$NI_t^N(UL) := \ln(C_t/SMA_t^N(UL))$$

So the sign of the normalized indicator will show the direction of the trend and the absolute size the strength.

We will then set up basically a linear log-log (as we have lognormalized all the variables) to regression model using the factors accordingly:

$$r_t^C = \beta_0 1 + \beta_1 r_t^O + \beta_2 NI_t^{50} + \beta_3 NI_t^{200} + \beta_4 H_t^{log} + \beta_5 L_t^{log} + \varepsilon$$

The Data

We will use only publicly available and free of charge data as from the following sources:

- <https://www.google.com/finance>
- <https://finance.yahoo.com/>

The index constituents and session infos about trading hours can be

- Xetra Vienna

Session infos:

<https://www.wienerbourse.at/en/trading/trading-information/trading-hours/>

ATX index constituents:

https://www.wienerbourse.at/en/indices/index-values/composition/?ISIN=AT0000999982&ID_NOTATION=92866

- Xetra Frankfurt

Session infos:

<https://www.xetra.com/xetra-en/trading/trading-models/auctionschedule>

DAX index constituents:

<http://en.boerse-frankfurt.de/index/constituents/DAX#Constituents>

- WSE Warsaw

Session infos:

<https://www.gpw.pl/session-details>

WIG20 index constituents:

<https://www.gpw.pl/index-factsheet?isin=PL9999999987>