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# Restraining Participation:
# The Effect of Limit Prices on Consistency Scores

The theory of constraints states that the throughput of any system is determined by one constraint (bottleneck). Thus to increase the efficiency of a process, one must focus on identifying and improving the bottleneck or constraint.

One of the constraints often placed on traders is the use of limit prices. We have seen that this hurts trading outputs, leading us to track what we call a consistency score. Let's investigate further.

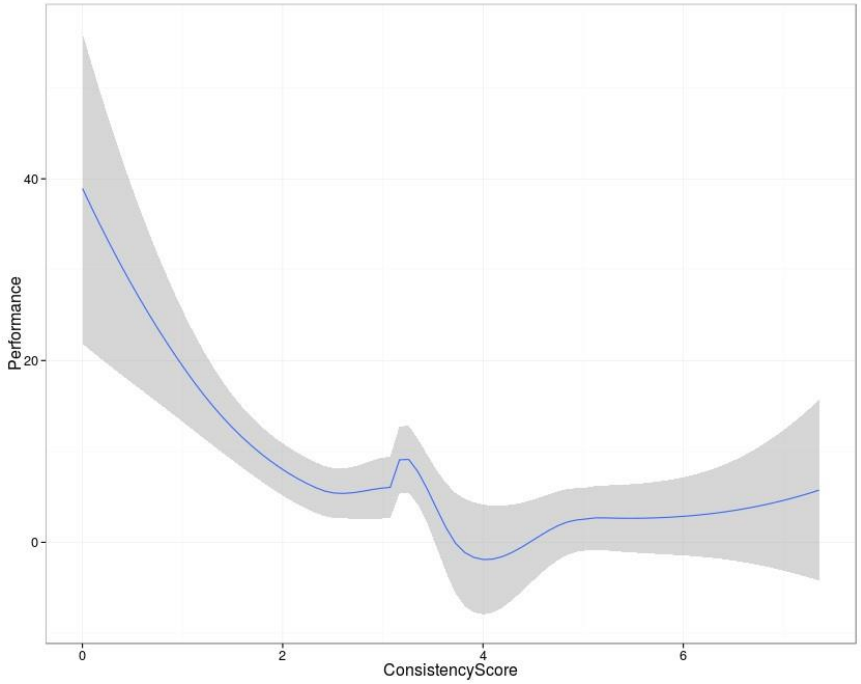


**Figure 1**: Traders' Consistency Scores vs. Performance (bps)

A consistency score (CS) measures how evenly trades are parceled into the market given different trading conditions. CS is defined as the ratio of participation rates in favorable momentum environments, or "gain frames" ($R_G$), to participation rates in adverse momentum environments, or "loss frames" ($R_L$). That is to say, $CS = \frac{R_G}{R_L}$.

In trading, a gain frame is one in which prices are falling as you are buying and rising as you are selling, that is orders are becoming easier to trade and are thus likely to put you in a positive frame of mind. In a loss frame prices are rising as you are buying and falling as you are selling.

Our research has shown that a ratio of one or less translates into better trading performance (i.e., realized trading costs lower than forecasted costs), as seen in Figure 1.

This means that, at a minimum, orders should be executed at identical participation rates in both gain and loss frames. Executing slower in favorable momentum environments and faster in adverse momentum conditions would result in a consistency score less than one, which historically has translated into even better performance (or lower trading costs), as shown in the graph above. This behavior is contrary to what we witness in the market, where orders are typically completed quickly in gain frames and extended in loss frames – resulting in a consistency score greater than one – and typically leads to higher trading costs.

## Effect of Constraints on Consistency Score:

To see how a consistency score is affected by tight limit prices (those that are close to prevailing prices), let's take a closer look at how a few different orders interact with the market.

### Gain Frames:

Limit prices will often have no effect on participation rates in a gain frame. Consider stock XYZ, trading at $10.00. If you place a buy order with a limit price, you would expect the order to be fully completed whether the limit was $10.05 or $10.75. Since a gain frame means prices fall as you are buying, stock XYZ will never rise above its initial $10.00 and thus the order will be completed regardless of the limit price.

Sell orders will *also* be unaffected by limit prices in a gain frame. If you placed a sell order for XYZ (still trading at $10.00), a limit price of $9.95 or $9.25 would have no effect on the order since a gain frame means prices are rising as you are selling. Therefore, regardless of whether you are buying or selling, your realized participation rate in a gain frame will be equal to your planned participation rate ($R_{Plan}$). Mathematically, $R_G = R_{Plan}$.

### Loss Frames:

Limit prices play a *much bigger* role in loss frames. If stock XYZ is trading at $10.00 when you submit a buy order with a limit price of $10.05, only a small portion of your order is likely to execute before the rising price (which defines a loss frame for a buy order) equals and then rises above this tight limit price. A looser limit price, such as $10.75, might sometimes leave room for the entire order to execute, but a particularly fast market or large order will mean that even a loose limit price can reduce your participation rate in a loss frame.

Similarly, a sell order for security XYZ in a loss frame (i.e., prices falling) will likely execute only a small fraction of its shares with a tight limit price of $9.95. Even a looser limit price such as $9.25 might not always be fully completed.

It is clear from these examples that a participation rate in a loss frame for orders with a loose limit price ($R_L$ (loose)) will be larger than for orders with a tight limit price ($R_L$ (tight)).

Any limit price, however, will reduce your realized participation rate in loss frames. Mathematically, $R_L(\text{tight}) < R_L(\text{loose}) < R_{Plan}$.

Earlier, consistency score was presented as $CS = \frac{R_G}{R_L}$, the ratio of participation rate in a gain frame to participation rate in a loss frame. Since our goal is to examine the impact of limit prices on consistency score, we can see from above that limit prices in general, and tighter limit prices specifically, will raise the consistency score by impacting (i.e., reducing) the participation rates in loss frames and thus negatively impact trading performance.