Journal of Banking and Finance Management
Volume 1, Issue 3, 2018, PP 17-18

A Note on Visualizing the Optimal Time for Closing a Momentum Trade

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ABSTRACT

In this paper, a simple method is presented to visualize the optimal time for closing a momentum trade. The decision criterion is based on discounted financial asset price (like stock) at which discounted price is computed with a minimum attractive rate of return. It is seen that as soon as, the discounted price starts decreasing is the best time for closing a momentum trade.

Keywords: *Geometric Brownian motion; Momentum trade; Stopping time*

INTRODUCTION

Ekstrom and Lindberg (2011) proposed a strategy, based on Bayesian posterior probability, for optimal closing time of a momentum trade. They supposed that the financial asset price (say a stock) obeys a geometric Brownian motion with a change point in drift. Indeed, they assumed that

$$ds = \mu_t s dt + \sigma s dB,$$

where B is a Brownian motion and $\mu_t = \theta_1$ for $t \leq \tau$ and $\mu_t = \theta_2$ for $t > \tau$. The optimal strategy solution is obtained by

$$V = max_{\tau^* \in F} E\left(e^{-r\tau^*} s_{\tau^*}\right),$$

where F is the collection of all stopping times τ^*. However, one can see that

$$E(e^{-rt} s_t) = \begin{cases} (\theta_1 - r) & t \leq \tau \\ (\theta_1 - \theta_2)\tau - (r - \theta_2)t & t > \tau. \end{cases}$$

This function attains its maximum at τ if $\theta_2 < r < \theta_1$. If $\tau < \infty$ with probability one, then $E\left(e^{-r\tau^*} s_{\tau^*}\right) = E(e^{-rt} s_t)$, using the optional sampling theorem. Indeed, for all $\tau^* < \infty$, then $E\left(e^{-r\tau^*} s_{\tau^*}\right)$ attains its maximum at τ. Here, conditions are extracted to make sure that

$$M_t = \frac{e^{-rt} s_t}{E(e^{-rt} s_t)},$$

is close to 1 and then $e^{-rt} s_t$ is used instead of $E(e^{-rt} s_t)$. It is easy to see that

$$M_t = \exp\left(\sigma B - \frac{\sigma^2 t}{2}\right) = \exp\left(\sigma(B - \frac{\sigma t}{2})\right),$$

and that M_t is a martingale with respect to filtration $\sigma(B_u, u \leq t)$, i.e., the sigma-field generated by $(B_u, u \leq t)$. It is clear that when $\sigma \to 0$, then $M_t \to 1$. Also, Doob inequality (see Bjork, 2009) implies that, for some maturity L, then $P(sup_{0 \leq t \leq L} M_t > \varepsilon) \leq \frac{E(M_L^\alpha)}{\varepsilon^\alpha}$ for some $0 < \alpha < 1$. Also, $E(M_L^\alpha) = \frac{-\alpha(1-\alpha)\sigma^2}{2} L$. Thus, $\frac{E(M_L^\alpha)}{\varepsilon^\alpha} = \exp\left(-\alpha\left\{\frac{(1-\alpha)\sigma^2}{2} L + \log(\varepsilon)\right\}\right) \leq \exp\left(-\alpha\left\{\frac{\sigma^2}{2} L + \log(\varepsilon)\right\}\right)$.

Assuming $\frac{\sigma^2}{2} L = -\log(\varepsilon)$, then $L = \frac{-2\log(\varepsilon)}{\sigma^2}$. Thus, by sequentially search for existence of momentum during intervals with length L, recursively, as soon as $e^{-rt} s_t$ starts to decrease, that time point is a suitable point for selling the asset. The following proposition summarizes the above discussion.

Proposition 1

Assuming $L = \frac{-2\log(\varepsilon)}{\sigma^2}$, by search recursively time intervals with length L, the momentum is detected.

Proof. It is discussed in section 1.

Thus, the estimate for τ is the time point at which $e^{-rt} s_t$ attains its maximum. That is,

$$\hat{\tau} = \text{argmax}_t\{e^{-rt} s_t\}.$$

Since, $e^{-rt} s_t$ is too close to its mean and $E(e^{-rt} s_t)$ takes its maximum at actual change point τ, thus, $\hat{\tau}$ is a consistent estimator for τ. The following proposition summarizes this fact.

Proposition 2

The estimator $\hat{\tau}$ is a consistent estimator for τ.

The rest of paper is organized as follows. First, the simulation results are derived in the next section. Section 3 concludes.

SIMULATIONS

Here, using the *Model Risk* adds-in of Excel, this case is simulated that $\theta_1 = 0.002, \theta_2 = 0.007, \tau = 543$, initial value of stock is 0.38 $,

$\sigma = 0.025$ and $\varepsilon = 0.01$. Let $r = 0.005$. The time period of study is 1000 days. The following plot shows the time series of $e^{-rt}s_t$ which implies that there is a change about 543.

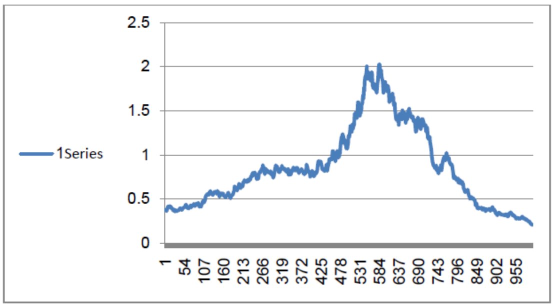

Figure 1. *Time series plot of* $e^{-rt}s_t$

While the time series of s_t is given as follows. However, the Fig.1. has better visual interpretation.

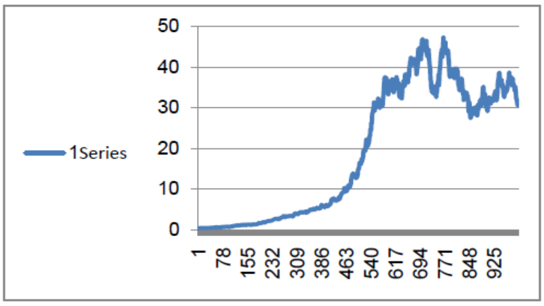

Figure2. *Time series plot of* s_t

As follows, the empirical distribution of $\hat{\tau}$ is given. Clearly, $\hat{\tau}$ is concentrated well on actual momentum time τ.

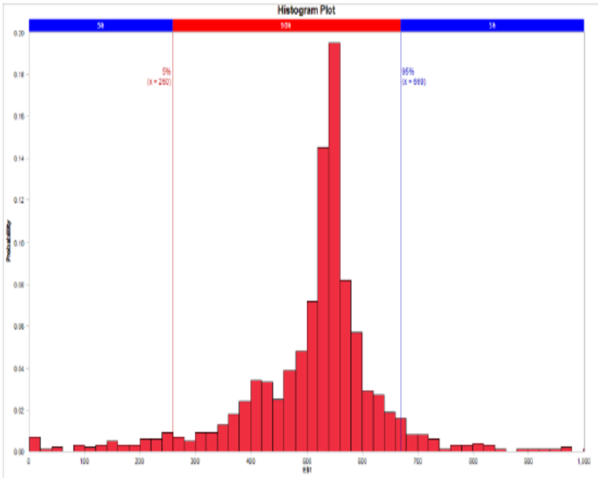

Figure 3. *Histogram of* $\hat{\tau}$

Here, a threshold K is given such that $P(max_t e^{-rt}s_t \leq K) = 1 - \alpha$. The following table gives some values for K, for various selections for α.

Table 1: *Values of K*

α	0.1	0.05	0.025	0.01
K	2.71	3.42	3.79	4.81

CONCLUSION

The argmax time point of $e^{-rt}s_t$ is a consistent estimator of actual momentum point. The time series plot of $e^{-rt}s_t$ has a good visualization for momentum time point.

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Citation: *Reza Habibi." Visualizing the Optimal Time for Closing a Momentum Trade". (2018). Journal of Banking and Finance Management, 1(3), pp.17-18*