1. Essay one

1.1 Introduction

Stop-loss rules, which involve selling a security when its price drops to a pre-determined threshold and buying the security back when its price rises a pre-specified amount, are widely used in financial markets (Han, Zhou and Zhu, 2016). There are two types of these rules - traditional and trailing stop. Traditional stop-loss rules are either price based or time based. Price based traditional rules involve selling when the price falls a certain percentage below the purchase price, irrespective of the price path since the purchase price, while time based rules involve selling if the price moves a certain percentage below the entry price within a specified time interval. Trailing stop-loss rules, in contrast, are more dynamic in that the sell trigger price is adjusted upwards if the price moves higher following a purchase. These rules are therefore designed to protect profits. The purpose of this paper is determining the extent to which trailing stop-loss (hereafter TSL) rules can protect against losses.

It is possible that one of the factors behind the popularity of trailing stop loss rules is the focus of investors on percentage price declines from high points. Many commentators refer to a “correction” as having occurred when price declines 10% from its recent high.\textsuperscript{1} While traditional stop loss rules are not referenced against recent high prices and declines from these levels, trailing stop loss rules are. They are therefore consistent with the media attention around percentage price declines from recent high prices. The tight trailing stop-loss rules with a stop-loss threshold less than 10% is thus a mechanism that can be used to avoid corrections.

\textsuperscript{1} For instance, Sheetz (2018) notes “The Nasdaq Composite Index on Thursday became the first major U.S. stock market benchmark to dip into a correction, dragged down by losses across all the major technology-related companies. A correction on Wall Street is defined as down more than 10 percent from its high.”
We investigate the performance of trailing stop-loss rules compared to a simple buy-and-hold (hereafter BH) approach in U.S. stocks over the 1926-2016 period. Bessembinder (2018) notes that delisting returns can have an important impact on equity returns over time, and it is possible that stop-loss rules are particularly effective at avoiding large losses on stocks that delist, so we include these returns in our analysis.

Our results, which are based on a TSL thresholds ranking from 1-20% indicate that a simple buy-and-hold approach generates larger returns than TSL rules. The level of risk, as measured by the standard deviation of returns is lower for TSL rules, but the lower mean return more than offsets this leading to a lower Sharpe Ratio for these rules. However, the value of TSL rules becomes clear when utility analysis results are considered. Each TSL rule generates larger utility than the BH approach for risk-aversion coefficients of one, three, and five. Measures of downside risk further highlight the benefits of TSL rules. Both VaRs and Expected Shortfall measures reveals materially less downside risk from the TSL rules than the BH approach. Our results hold across all stocks, but are particularly strong among the group of stocks that end up delisting. TSL rules have become more effective through time. They add more value in declining markets and perform the best on stocks that are more volatile and liquid, and with a lower book-to-market ratio.

We contribute several strands of the literature. First, we add papers that consider stop-losses. Kaminski and Lo (2014) suggest that time based traditional stop-loss rules underperform under random walk and mean-reversion markets but outperform under momentum and regime-switching models. Lo and Remerov (2017) consider various aspects of the downside risks of time-based traditional stop-loss rules and find a positive relation between the extent of return serial correlation and the performance of these rules. Han et al. (2016) show that price based traditional stop-loss rules reduce the downside exposure and double the Shape ratio of momentum strategies in the U.S. equity market. Furthermore, Fischbacher, Hoffmann
and Schudy (2017) find price based traditional stop-loss rules can reduce the impact of the disposition effect and decrease the realized losses. A number of papers have also study various aspect of TSL rules. Using traditional risk metrics Lei and Li (2009) find that TSL rules neither increase or reduce the losses experienced by investors relative to a buy and hold strategy. Clare, Seaton, Smith, and Thomas (2013) show TSL rules do not add value to trend following rules. However, Snorrason and Yusupov (2009) find TSL rules outperform a buy-and-hold strategy in Sweden markets.

Second, we contribute to a broader strand of the literature that highlights the importance and implications of path of returns in additional to the average return. Shleifer and Vishny (1997) point out that asset managers who manage capital on behalf of outside investors often avoid volatile arbitrage opportunities due to the risk that their investors will request that their capital be returned during periods of drawdown. Moreover, researchers such as Barroso and Santa-Clara (2015) and Daniel and Moskowitz (2016) consider the price path of the popular momentum strategy and highlight that while the overall average returns are positive there can be periods where large losses are incurred. TSLs are specifically designed to limit downside risk and prevent periods of large losses.

1.2 Data and trading rules

1.2.1 Data

We study all common stocks from CRSP database. 25,997 common stocks are selected including share codes of 10, 11 and 12 in the US markets from 1 July 1926 to 30 December 2016.² Bessembinder (2018) highlights the importance of considering delisting returns so we follow his approach and include these in our analysis. To include the effect of delisting return, we compound the two returns if both regular return in the last trading day and delisting return

² All missing returns are deleted.
are available.\textsuperscript{3} We ignore the impact of delisting returns for stocks that have missing delisting returns from the CRSP database.\textsuperscript{4}

\subsection*{1.2.2 Description of the rules}

We compare two approaches to investing in each stock. A simple \textit{BH} approach and \textit{TSL} rules. Both approaches are established at the start of each stock’s data series. The \textit{BH} approach involves buying and holding the stock for the entire period. The \textit{TSL} approach involves selling the stock when it declines X\% from its high price and only buying it back when it increases X\% above its low price. The initial trailing stop loss trigger price (TSLTP) is set at X\% below the price the stock is purchased at. If the stock price does not increase the TSLTP remains at this initial level. However, if the stock price increases beyond the initial purchase price the TSLTP is increased so that it is X\% below each new high price. When the price falls below the TSLTP a sell signal is generated. Lo and Remorov (2017) note traditional stop-loss rules with one day delay in the transaction can increase the performance as it captures the reversed returns in the day after the trigger. It is also a more practical way for investors to close the position on the day following the trigger. We consider to exit the position on the day following the TSLTP being hit (regardless of the price movement on that day). A position in T-bills is entered at the end of the day on the day the stock is sold.

The T-bills position is maintained until the stock price rises above the buy trigger price (BTP), which is initially set at X\% above the closing price on the day the previous long position was exited. As with the TSLTP, the BTP decreases each day if the price falls below the price the long price was exited.

\textsuperscript{3} Some stocks have the missing return, which is deleted at the beginning, in the last trading day. We compound the delisting return to the last existing return for these stocks.

\textsuperscript{4} The definitions of missing delisting codes are divided into four types. -55: “CRSP has no sources to establish a value after delisting or is unable to assign a value to one or more known distributions after delisting”. -66: “more than 10 trading periods between a security's last price and its first available price on a new exchange”. -88: “the stock is still active”. -99: “security trades on a new exchange after delisting, but CRSP currently has no sources to gather price information”.

1.3 Results

1.3.1 Core results

Table 1 contains monthly returns, Sharpe ratios, utility analysis, and downside risk measures for the BH approach and the TSL strategy with the four thresholds of 1%, 5%, 10%, and 20%. The Panel A results indicate that mean returns are lower for each of the TSL strategies than the BH approach. TSL rules clearly do not add value when considered solely on the basis of mean returns. Risk, as measured by return standard deviation, is lower for each of the TSL rules than the BH approach, but the risk reduction is not sufficient to offset the lower returns, which results in lower Sharpe Ratios for the TSL rule than the BH approach.

In Panel B, the results indicate that each of the TSL rules generate a higher Certainty Equivalent Return (CER) than the BH approach. This applies to each risk aversion level, with the results indicating that the TSL rules out-perform the BH rule from a CER perspective when \( \gamma \) rises above 0.5.

The results in Panel C compare the TSL rules to the BH approach from a downside risk perspective. We report the Value-at-Risk (VaR) by calculating either 1 or 5 percentile in pooled monthly returns. The VaR indicates a potential loss level that can be reached by either the TSL or BH approach under a certain confidence level. The Expected Shortfall (ES) is the mean of monthly returns that are less than the respective VaR. The ES shows an expected loss to be achieved once the VaR is breached under the confidence level. The Panel C results indicate that each of the TSL rules has both the higher VaR and ES than the BH approach. The results hold across two confidence levels. The outperformance of TSL rules over the BH approach is even better when applying a tighter confidence level, such as 1%.

[Insert Table 1 About Here]
1.3.2 Time-series determinants

In this section, we consider the performance of TSL rules though time. We focus on downside risk as it seems reasonable to assume that stop-loss rules were developed to “stop losses” rather than minimise risk measures such as volatility. We select CER with a $\gamma$ of 3 as a proxy of the risk-adjusted performance, both VaR and ES are at 1% level as downside exposures.

Our results show TSL approaches have an increasing trend in enhancing risk-adjusted performance and reducing downside risks over time. The TSL approaches have even higher CER than the BH approach during recessions for investors with a risk reversion level of 3. However, the effectiveness of TSL approach in controlling downside risks is not significantly affected by NBER business cycles. In terms of the financial market states, our results suggest the TSL approaches have particularly higher CER and downside exposures than the BH approach during DOWN markets.

1.3.3 Cross-sectional determinants

In this section, we compare and contrast a series of cross-sectional factors that have the impact on the effectiveness of TSL and BH approaches at reducing downside risks. We investigate six cross-sectional factors, which are size, B/M ratio, liquidity, volume, price, and volatility. Our results show the TSL approach is more effective at reducing downside risks for stocks with the higher liquidity, volume, volatility, and the lower B/M ratio.
2. Essay two

2.1 Introduction

This paper investigates the impact of trailing stop-loss rules on allocation across different assets. We focus on two methods of asset allocation, which are the naïve 1/N diversification rule and the Parametric Portfolio Policies (PPP thereafter) proposed by Brandt, Santa-Clara and Valkanov (2009).

Markowitz (1952) proposes the mean-variance model for asset allocation. This remains a popular portfolio allocation method up to the present. This model suggests an efficient portfolio that has the minimum variance for a given level of expected returns, or the maximum expected returns for a given variance (Markowitz, Todd, & Sharpe, 2000). However, recent studies note a problem with the Markowitz portfolio, in that it has estimation errors in practice that result in the parameters in the model deviating greatly from the true optimal model (Tu and Zhou, 2011). Existing papers find that the Markowitz mean-variance approach does not perform well and even underperforms the 1/N diversification rule (e.g. DeMiguel, Garlappi and Uppal, 2007; Duchin and Levy, 2009; Jobson and Korkie, 1980;). The naïve 1/N diversification rule is an asset allocation method that equally assigns weights across all assets at each portfolio rebalancing date (Guo, Boyle, Weng and Wirjanto, 2018). DeMiguel et al. (2007) find that the naïve 1/N portfolio outperforms all 14 models across 7 empirical datasets.

Brandt, Santa-Clara and Valkanov (2009) construct optimal portfolios by optimising the utility of the portfolio’s return. They examine size, B/M ratio and momentum return as three characteristics in order to set the weight. This method helps to allocate weights across a large number of assets. In this essay, we apply trailing stop-loss rules to each asset in the portfolios by allocating assets as per either PPP or the 1/N diversification rule.

This study has several contributions. First, some studies investigate the performance of portfolios by combining the 1/N portfolio with sophisticated asset allocation strategies. For
instance, Tu and Zhou (2011) find outperformance of the combined asset allocation rules, which is important in the existence of estimation errors. This even further diversifies portfolio risk. To the best of our knowledge, we are the first paper that applies trailing stop-loss rules to either the 1/N diversification rule or PPP. It is interesting to consider whether applying trailing stop-loss rules to an asset allocation rule improves the performance of optimal portfolios, compared with optimal portfolios using the single asset allocation rule.

Second, career risk is an essential concern to fund managers. Ellul, Pagano and Scognamiglio (2018) suggest that top managers in a hedge fund are likely to be demoted and incur high compensation losses if their funds are liquidated after two-years of underperformance. As a consequence, fund managers tend to avoid the drawdown risk of portfolios. It is of interest for fund managers to understand whether stop-loss rules can further reduce crashes or the risks of diversified portfolios.

2.2 Data

We investigate two samples in this study. The first sample investigates the international equity markets. The portfolio is formed from several different asset in the second sample. For the first sample, we follow Pukthuanthong and Roll (2014) to source global equity indexes data from Datastream. This covers indexes for 82 markets worldwide.

2.3 Methodology

The naïve 1/N diversification rule involves assigning 1/N weight for each holding asset in the portfolio that has N assets. Brandt et al. (2009) construct optimal portfolios by optimising the utility of the portfolio’s return. They examine size, B/M ratio and momentum return as three characteristics in order to set the optimal weight. We include the trailing stop-loss rules as a characteristic by forming a dummy variable as per implied position in assets.
3. References


Table 1
Core Results for All Stocks

<table>
<thead>
<tr>
<th>Variable</th>
<th>RF</th>
<th>BH</th>
<th>TSL 1%</th>
<th>TSL 5%</th>
<th>TSL 10%</th>
<th>TSL 20%</th>
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<tbody>
<tr>
<td>Panel A: Returns and Sharpe Ratios</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Return (%)</td>
<td>0.37</td>
<td>1.13</td>
<td>0.98</td>
<td>0.85</td>
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<td>Std Dev (%)</td>
<td>0.26</td>
<td>18.07</td>
<td>13.45</td>
<td>13.58</td>
<td>13.71</td>
<td>14.20</td>
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<tr>
<td>Sharpe Ratio</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.03</td>
<td>0.04</td>
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<tr>
<td>PSR</td>
<td>0.00</td>
<td>5.29</td>
<td>-14.25</td>
<td>-20.48</td>
<td>-14.01</td>
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<tr>
<td>Panel B: Utility Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>CER 1 (%)</td>
<td>-0.50</td>
<td>0.07</td>
<td>-0.07</td>
<td>-0.13</td>
<td>-0.13</td>
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<tr>
<td>CER 3 (%)</td>
<td>-3.76</td>
<td>-1.74</td>
<td>-1.92</td>
<td>-2.01</td>
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<td>CER 5 (%)</td>
<td>-7.03</td>
<td>-3.55</td>
<td>-3.76</td>
<td>-3.89</td>
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<tr>
<td>Break-even Gamma</td>
<td>0.22</td>
<td>0.40</td>
<td>0.47</td>
<td>0.42</td>
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<td></td>
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<tr>
<td>Panel C: Downside Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VaR (1%)</td>
<td>-39.22%</td>
<td>-29.18%</td>
<td>-28.48%</td>
<td>-28.17%</td>
<td>-28.49%</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>ES (1%)</td>
<td>-50.62%</td>
<td>-39.43%</td>
<td>-38.74%</td>
<td>-38.33%</td>
<td>-38.52%</td>
<td>&lt;.0001</td>
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<tr>
<td>VaR (5%)</td>
<td>-22.07%</td>
<td>-15.53%</td>
<td>-15.11%</td>
<td>-15.01%</td>
<td>-17.14%</td>
<td>&lt;.0001</td>
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<tr>
<td>ES (5%)</td>
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<td>-24.21%</td>
<td>-23.62%</td>
<td>-23.37%</td>
<td>-24.68%</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

Note: This table presents the TSL and BH results for all common stocks with share codes of 10, 11, and 12 from CRSP. We conduct TSL approach with thresholds of 1%, 5%, 10%, and 20%. In Panel A, we display the return, standard deviation, and Sharpe ratio. The PSR (Probabilistic Sharpe ratio), which is a Z-score, shows the confidence level that the Sharpe ratio of TSL is greater than that of BH. Panel B shows utility of investors with different risk aversion levels. These are reported in percent. The break-even Gamma shows a risk aversion level that makes the CER of TSL approach equals to that of BH approach. Panel C displays the Value-at-Risk (VaR) and Expected Shortfall (ES), which are two measures of downside risks. The P-value is calculated by testing the differences between two downside measures for each stock between two approaches.