An evaluation of non-linear trading rules on weekly data

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Parameter:

Our predictor depends on the values of a few input parameters, including 1) embedding dimension m, which is assumed to be 5 in our case; 2) the number of closest k points in the phase space, and 3) filter value for changing position. Rule of thumb for picking k is to take square root of the number of data set available. We have weekly data between January 1928 and December 2015, namely about ~4600 weeks. The square root rule gives us k of 68. To justify the correctness of square root rule, tests (Table Figure 1) were ran on k ranging from 40 to 100, and the best outcomes did show around 68. The selection of filter value of 0.1%, 0.2% and 0.3% is also determined based on testing results. Transaction cost also has an compact on the performance of KKN model, however, for the purpose of this report, we use one-way transaction costs of 0.05% for all the transaction occurred.

	Excess Return (2006 - 2015)						
filter(%) \ k	40	50	60	70	80	90	100
0.1	-4.61%	1.32%	2.98%	1.39%	0.95%	1.03%	-0.58%
0.2	-2.57%	1.54%	2.47%	1.64%	2.04%	1.14%	0.61%
0.3	-0.85%	0.81%	1.14%	0.69%	2.54%	0.91%	-0.43%
0.4	-0.69%	0.07%	2.30%	0.97%	0.18%	1.45%	-1.79%
0.5	-0.57%	-0.22%	0.14%	-0.40%	1.20%	-0.56%	-2.11%

Table Figure 1

Testing Summary:

With appropriate values selected for parameters, additional test cases were examined for different period of the testing period (Jan 2006 – Dec 2015). They are 1) Jan 2007 - Dec 2008 during the most recent financial crisis, a testing case for bearish market; 2) Dec 2010 – Dec 2011, where the market is volatile; 3) Dec 2012 – Dec 2013 during a market that's trending upwards throughout the year. Table Figure 2 shows an excess return summary on four different testing periods. For details of the result from these periods, please refer to Summary Tab in 'Source Data.xlsx' file.

As illustrated in the table, our predictor generates positive excess return compared to Buy-and-Hold strategy over the entire testing period. Remarkable excess returns are presented on the time period of financial crisis. This may be due to the fact that we are taking either long or short position at any point of time, which allows us to take advantages of extra returns when our model produces 'Sell' signal during financial crisis, while the Buy-and-hold strategy's return is constrained. During volatile market (Year 2010), we see both positive/negative outcomes based on parameters, with positive excess returns are produced most of the time. In the last testing period (Year 2013), we only find positive excess return with k = 70 and filter = 0.3%. This indicates our predictor still needs improvement in forecasting market correction. If we buy risk-free security instead of taking short position when a 'Sell' signal is produced, KNN model is likely to produce similar return as Buy-and-hold strategy during bullish mark.

Excess Return Summary

		Filter = 0.1%			Filter = 0.2%			Filter = 0.3%		
		K = 65	K = 70	K = 75	K = 65	K = 70	K = 75	K = 65	K = 70	K = 75
cess return	1) Jan 2006 - Dec 2015	2.64%	1.39%	2.96%	2.29%	1.64%	2.28%	1.08%	0.69%	2.1
	2) Jan 2007 - Dec 2008	15.09%	15.26%	22.76%	16.31%	15.47%	22.51%	13.98%	15.46%	20.3
	3) Dec 2010 - Dec 2011	6.43%	-0.96%	8.42%	15.47%	6.33%	8.95%	15.47%	9.60%	9.2
	4) Dec 2012 - Dec 2013	-7.01%	-4.44%	-4.29%	-4.94%	-4.02%	-3.10%	-3.03%	1.28%	-0.1

Table Figure 2

Shape Ratio:

Table Figure 3 shows the Sharpe ratio results for the trading rule based on the NN predictor, using transaction costs of 0.05%. For the testing case that covers the entire testing period, the NN-based trading rules yields positive Sharpe ratios for all selected parameters. Negative Sharpe ratio is only seen with filter at its lower end (0.1%) and the last two time periods. Sharpe ratio tends to be higher with grater filter value (0.3%) and k value (75).

Sharpe Ratio Summary

	Filter = 0.1%			Filter = 0.2%			Filter = 0.3%		
	K = 65	K = 70	K = 75	K = 65	K = 70	K = 75	K = 65	K = 70	K = 75
1) Jan 2006 - Dec 2015	0.358	0.257	0.400	0.330	0.276	0.344	0.221	0.198	0.3
2) Jan 2007 - Dec 2008	0.513	0.524	0.985	0.575	0.527	0.973	0.425	0.526	0.8
3) Dec 2010 - Dec 2011	0.512	-0.003	0.666	1.157	0.474	0.723	1.157	0.724	0.7
4) Dec 2012 - Dec 2013	-0.071	0.380	0.411	0.326	0.508	0.581	0.640	1.508	1.1

harpe ratio

Table Figure 3

P & L:

Based on our testing result from Table 2, with combination of k =75 and filter = 0.1%, NN-based trading rule yields the greatest excess return over the entire testing period (Jan 2006 – Dec 2015). We then use these parameters to generate our weekly P&L. We assume initial capital under both NN-based trading strategy and Buy-and-hold strategy to be $100 for easy calculation. The weekly P&L from 2006 to 2015 can be found under 'P&L' Tab in 'Source Data.xlsx'. NN-based trading rule outperforms Buy-and-hold strategy and S&P 500 index over the same period of time (S&P 500 went from 1268.8 in 2006 to 2044 in 2015, an increase of 61%).