Designing Automated Trading Systems for Commodity Trading – Practical Aspects

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Designing Automated Trading Systems for Commodity Trading – Practical Aspects

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Abstract. Practical application of automated trading system requires extensive testing and background knowledge of principles of used tools. Especially technical analysis indicators, which are considered to be basic instrument for designing automated (mechanical) trading systems, may be optimized or modified to serve individual trader's needs. Also, each market environment is specific and identical indicators work differently and with various results in different markets. This chapter is focused on testing and optimization of technical analysis tools from the perspective of designing automated trading system for small speculator use on commodity markets, as well as testing of application of selected exit strategies on automated trading system's performance.

Keywords. Automated trading system, commodity, futures, trading, mechanical trading.

Introduction

Futures trading is considered to be one of the most risky and profitable form of investing, both at the same time. It is a fact that governing principles of trading with stocks or options, for example, are not so different. Tools, data, platforms and even trading strategies may be similar or possibly the same. The major difference here is combination of very quick trading (fast decision making) and leverage effect. This magnifies advantages of automated trading systems` application, as they allow trader to concentrate more on details of trade and ease his/her workload.

This chapter is focused on optimizing system`s performance and risk management features of automated trading systems (ATS). All test results presented in this text were made on real, reliable, high-quality commodity data.

The problem domain will be studied from the perspective of a small speculator. This approach allows freedom of choice when strategy is selected or indicator modified. Also, it maximizes potential of ATS use, because individual trader is completely dependent on his/her own limited sources and personal abilities.

Chapter is divided into two main parts. First part will be focused on optimizing technical indicator`s performance, second part will be related to the area of risk management, specifically testing of selected exit strategies and evaluating their performance on selected markets.

1. Optimizing Performance of Technical Analysis Indicator

The technical analysis is essential for construction of automated trading system. When two main approaches – fundamental and technical analysis - are considered, it is technical analysis which is better suited for computer (mechanical) processing. With exception of pattern recognition and its consequent analysis (which some authors consider part of technical analysis approach), technical indicators are easy to implement in trading platforms, see [1] or [3] for more details.

The universal optimization procedure for technical analysis indicators will be presented in this part of the text. For explanation purposes, Moving Averages Convergence/Divergence indicator (MACD) will be used, because it is quite straightforward in principle, easy to imagine, understand and work with and MACD or its derivatives (i.e. moving averages-based indicators like Bollinger Bands or some variants of Stochastics indicator) are extensively used by traders. It is also supported or implemented in most (if not all) trading platforms, which makes it easy to use and accessible.

1.1. Principles of Technical Analysis Indicator - MACD

Technical analysis (TA) is based on price chart data. This makes it more reliable than fundamental analysis (FA), see [2], [5]. FA often relies on subjective or unreliable evaluation of situation (press information, government proclamation, expert analysis and forecasts in media, etc.). Basically, FA is generally more useful for slower trading (like stocks, etc.). FA is more useful in long term trend recognition; fundamental information tends to have long-term effect on markets. TA is based on more objective information and is more useful in faster ways of trading (like commodities). It is also more suitable for machine processing. These facts together makes TA ideal tool for technical trader and majority of commodities traders are technical traders.

For explanation of optimization procedure will be used MACD indicator. MACD indicator is based purely on price chart data. According to [3], following formulas (1) to (4) are used to obtain MACD signal:

$$EMA(12) = today\ CLOSE * \left(\frac{2}{12+1}\right) + previous\ EMA\ (9) * \left(1 - \left(\frac{2}{12+1}\right)\right) \tag{1}$$

$$EMA(26) = today\ CLOSE * \left(\frac{2}{26+1}\right) + previous\ EMA(26) * \left(1 - \left(\frac{2}{26+1}\right)\right) \tag{2}$$

MACD itself is obtained by application of following formula, where longer EMA is subtracted from shorter EMA:

$$MACD = EMA(12) - EMA(26) \tag{3}$$

For generation of trading signals, signal curve (SIG) is calculated using following formula:

$$SIGNAL = MACD * \left(\frac{2}{9+1}\right) + previous\ SIGNAL * \left(1 - \left(\frac{2}{9+1}\right)\right) \qquad (4)$$

Buy or sell signal is indicated when both curves create intersection, as it is shown at Fig. 1. Buy or sell signal is dependent on the direction of crossover (from below or from above). For more information, see respective literature (e.g. [2], [5] or [6]).

Figure 1. Creating buy/sell signals using MACD indicator

Formulas (1) to (4) represent one of several default forms of MACD indicator. Default (or standard) setting of MACD is (12-26-9) or (5-34-5)[1] for, respectively, *fa* curve (fast average), *sa* curve (slow average) and *sig* curve (signal).

1.2. Optimization of Technical Analysis Indicator

The optimization procedure is intended to improve trading systems` performance. Only a simplified version of trading system will be used for optimization procedure since it is not trading system we are interested in, but the indicator settings. Therefore, many important aspects of trading will be omitted (like commissions, specialized exit strategies, indicator combinations, etc.) in order to keep things easy to understand.

The optimization follows this sequence of steps:

```
1. Select indicator
2. Select indicator`s parameter
3. Define array range of valid parameter`s values
4. Set size of one optimization step (minimal
   difference between two values from array)
5. Repeat steps 2-4 for every indicator`s parameter,
   else step 6
6. Initialize parameter which is not selected for
   optimization (use its default value)
7. Define market entry condition (using parameters
   defined or initialized above)
```

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[1] List is not complete. There is generally unlimited number of combinations, but only several of them are considered to be default.

```
8. Define market exit condition (using parameters
   defined or initialized above)
9. Perform backtest on selected data
10. Perform optimization using combination of arrays
    and defined parameters
11. Show results (table, in case of two parameters
    chart)
12. Sort results by using user-defined criteria
```

For the purpose of optimization, we will use 9 as a fixed value for the computation of signal line. We will try to optimize remaining parameters of the MACD indicators, i.e. to replace 12-26 setting with more suitable values. For this purpose, the range of 3-20 will be used for faster MACD line and the range of 21-50 will be used for slower MACD line. The step value will be 1 and every optimization cycle will take 540 steps to be done, in order to process all available combinations. All considered trades will be long (speculation on the rise of price), with initial capital of 10.000 USD. No commission costs will be considered (these are dependent on broker services price and are related to selected market).

Table 1. Backtest report for cocoa market (CCZ9)

Report item	Default (12-26-9)	Optimized (4-21-9)
Initial capital	10 000.00	10 000.00
Ending capital	13 958.41	37 164.44
Net profit	3958.41	27 146.44
Net profit %	39.58 %	271.64 %
Exposure %	50.27 %	50.65 %
Net risk adjusted return %	78.74 %	536,35 %
Annual return %	2.88 %	11,81 %
Risk adjusted return %	5.72 %	23,31 %

For every commodity from our example, there is a backtesting report available, similar to one shown in Table 1 (report has been shortened due to the lack of space). The backtest report is a feedback confirmation of valid optimization and results for all tested commodities here will not be presented here. As it is shown in Table 1, the optimization generally leads to better results. Results are only theoretical, given the testing parameters, but the difference in net profit is significant here. Important attribute is annual return rate. We are dealing with case of investing 10 000 USD over twelve years; therefore an annual profit of 11.81% is not extremely high.
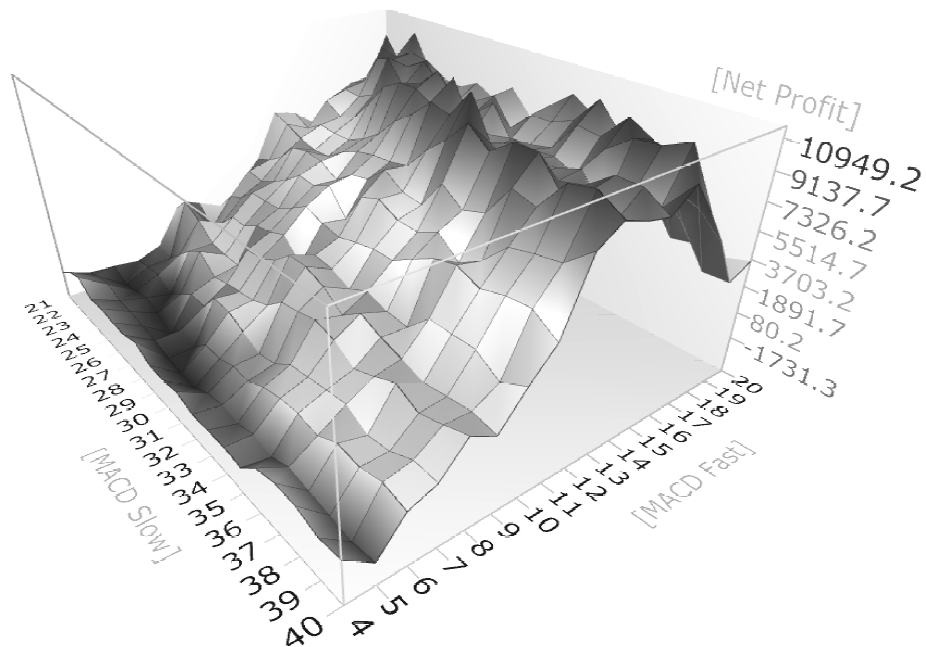
Figure 2. 3D graph representing all possible configurations of MACD indicator settings (high values of profit are highest values in graph) (example - cotton market).

Optimization results may also be represented in a form of graph. This is shown at the Fig. 2 (3D variant) and Fig. 3 (2D variant). Normally, colors are used for better orientation in these figures, but both examples were transformed to gray scale due to the print requirements.
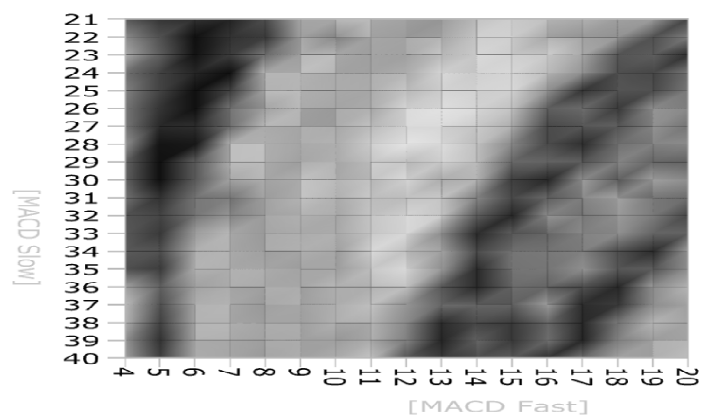

Figure 3. 2D graph representing all possible configurations of MACD indicator settings (example - cotton market)

1.3. Test Results

The testing will be limited to several markets. List of these markets along with used data range is shown in the Tab. 2.

Table 2. Commodities description

Commodity	Symbol	Data begin	Data end
Cocoa	CCZ9	December 1997	December 2009
Coffee	KCZ9	December 1997	December 2009
Cotton #2	CTZ9	December 1997	December 2009
Orange juice	JOX9	December 1997	October 2009
Sugar #11	SBV9	December 1997	November 2009

Optimization will be performed for 5 different markets: cocoa, coffee, cotton, sugar and orange juice (see Tab. 2). All these agricultural commodities are traded at NYBOT (New York Board of Trade, since 2007 ICE Futures U.S.). 1 minute timeframe will be used for data.
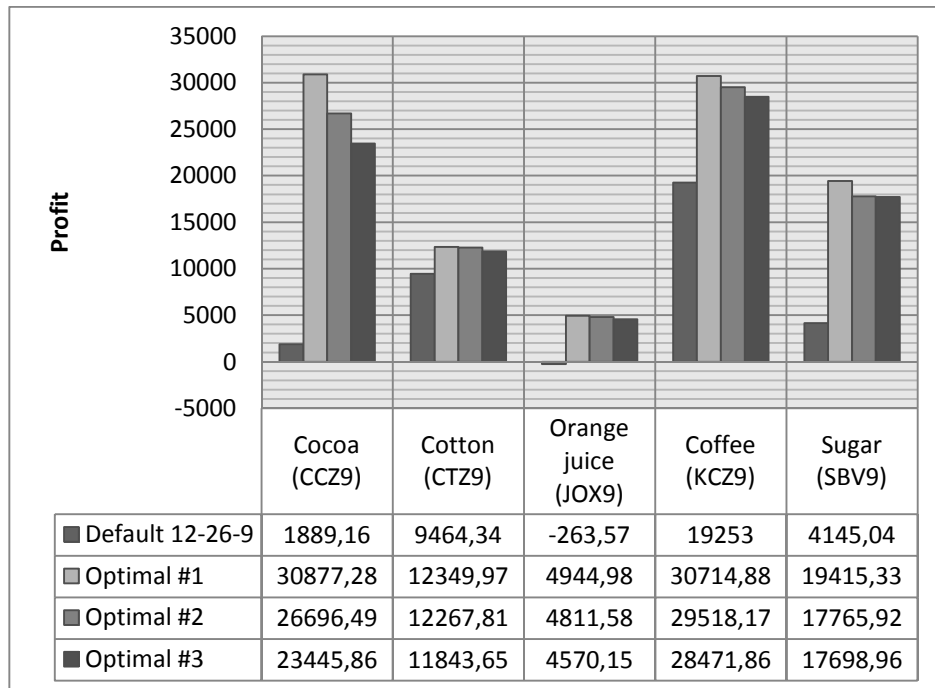

	Cocoa (CCZ9)	Cotton (CTZ9)	Orange juice (JOX9)	Coffee (KCZ9)	Sugar (SBV9)
■ Default 12-26-9	1889,16	9464,34	-263,57	19253	4145,04
■ Optimal #1	30877,28	12349,97	4944,98	30714,88	19415,33
■ Optimal #2	26696,49	12267,81	4811,58	29518,17	17765,92
■ Optimal #3	23445,86	11843,65	4570,15	28471,86	17698,96

Figure 4. Comparison of performance of default and optimized system setting

Results (part of results) of optimization are shown at the Fig. 4. It is obvious that optimizing leads to better performance. Setback is more difficult implementation.

Since it is not trading system itself we are interested in, let us settle for assurance that all optimized configurations are more profitable than their default counterparts,

although only part of results were shown at the Fig. 4. Tab. 3 shows results of optimization for 10 best configuration settings, see [8] for more details.

Table 3. Optimization results for MACD Fast and MACD Slow parameters

CCZ9 MACD Fast	CCZ9 MACD Slow	KCZ9 MACD Fast	KCZ9 MACD Slow	CTZ9 MACD Fast	CTZ9 MACD Slow	JOX9 MACD Fast	JOX9 MACD Slow	SBV9 MACD Fast	SBV9 MACD Slow
4	21	10	21	9	33	6	45	4	29
3	30	7	23	9	32	6	30	4	38
4	23	8	23	8	38	6	46	4	36
3	24	7	24	14	45	6	44	3	36
3	27	7	22	9	34	6	41	4	37
3	29	10	22	18	30	6	42	4	39
3	32	11	21	15	30	6	43	4	33
3	26	10	26	10	31	7	29	3	33
3	23	10	23	18	25	6	31	3	35
4	22	7	26	20	27	6	40	4	40

1.4. Correlation Analysis

The problem with results of optimization, as they are shown in the Tab. 3, lies in occasionally inconclusive results (e.g. CCZ9 MACD slow and JAX9 MACD slow columns in Tab. 3 – it is difficult to choose best settings, top 3 results are too far from each other). Generally, it is the net profit parameter we want to maximize, but apart from that there are other performance attributes of trading system we might want to use as well. This creates an opportunity to incorporate correlation analysis into process of optimization and take one or more of the rest of the attributes (correlated to net profit) into consideration. This might consequently help to clarify otherwise inconclusive results.

The correlation analysis will be limited to several factors connected to system`s performance:

- **Exposure** – reflects how large portion of trading account is used for trading. It is necessary to keep it at the minimum in order to distribute funds evenly and avoid risk of having large portion of trading account allocated in single trade.
- **Drawdown** (of the single trade or of the whole trading system) – maximum loss achieved during trading.
- **Risk reward ratio (RRR)** – ratio of amount of money invested and its return value in case of successful trade. Ratio is related to statistical analysis of backtesting results.
- **Number of trades** – every trade has transaction costs: slippage, broker fees, margins. This creates barrier for generating profit. It is generally better to have fewer trades with higher RRR than large number of trades with lower RRR.
- **Pay-off ratio** – ratio of average winning trade / average losing trade.

According to positivity or negativity of impact of each factor, following table may be used for correlation procedure (Tab. 4):

Tab. 4: Positivity or negativity of attributes.

Name	Optimum	Note
Exposure	-1	Negative attribute
Drawdown	-1	Negative attribute
Risk Reward Ratio	+1	Positive attribute
Trades	-1	Negative attribute
Pay-off Ratio	+1	Positive attribute

For correlation computation, following formula will be used:

$$\rho_{x,y} = \frac{cov(x,y)}{\sigma_x . \sigma_y} \qquad (5)$$

Here, *x* and *y* stands for mean values selection for array of values *average(array1)* and *average(array2)*. Correlation value of -1 means anti-correlation, value +1 means complete correlation. Value equal to 0 means non-correlation.
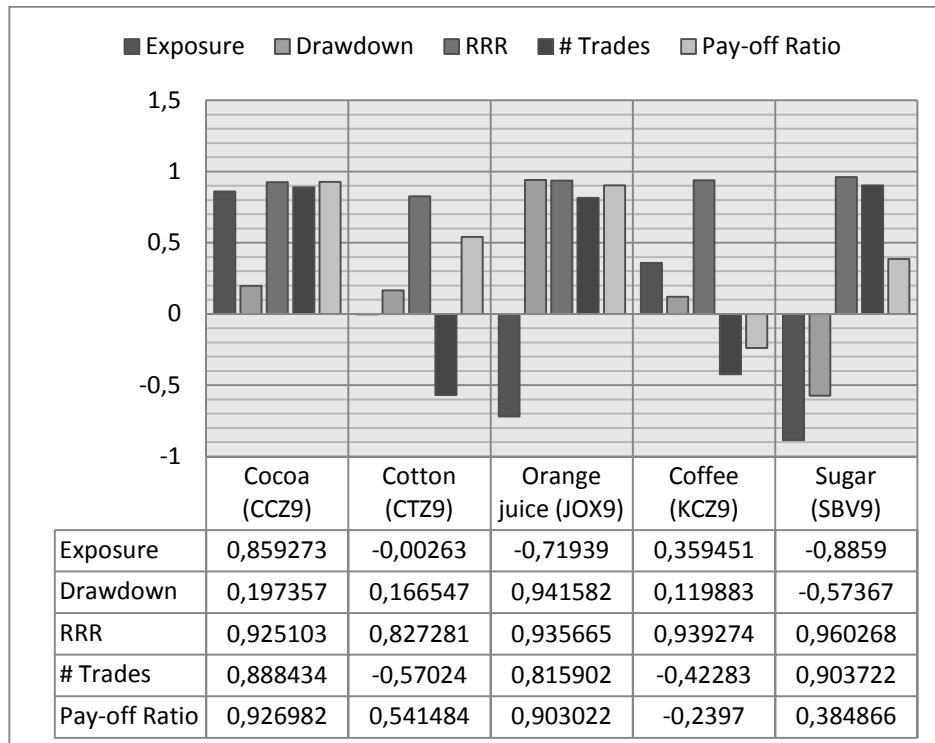

	Cocoa (CCZ9)	Cotton (CTZ9)	Orange juice (JOX9)	Coffee (KCZ9)	Sugar (SBV9)
Exposure	0,859273	-0,00263	-0,71939	0,359451	-0,8859
Drawdown	0,197357	0,166547	0,941582	0,119883	-0,57367
RRR	0,925103	0,827281	0,935665	0,939274	0,960268
# Trades	0,888434	-0,57024	0,815902	-0,42283	0,903722
Pay-off Ratio	0,926982	0,541484	0,903022	-0,2397	0,384866

Figure 5. Correlation analysis (between net profit and selected factors) results for MACD using *sig = 9*

Using similar settings as in the section 1.3 and Tab. 3, results were obtained by application of correlation analysis (see Fig. 5).

These results (Fig. 5) can be used to emphasize factor closely related to net profit which would help to clarify optimal settings for indicator parameters (as were described in the previous part).

1.5. Walk-Forward Analysis

Voluntary step in optimization procedure is application of walk-forward analysis (WFA). WFA allows trader to verify functioning of the system on other than training data. This leads to better and more reliable results of optimization process.

Application of WFA is shown at the Fig. 6. Segments of data are taken one after another. There are two types of segments – In-sample data (IS) and Out-of-sample data (OOS). IS represents training set and OOS verification set.
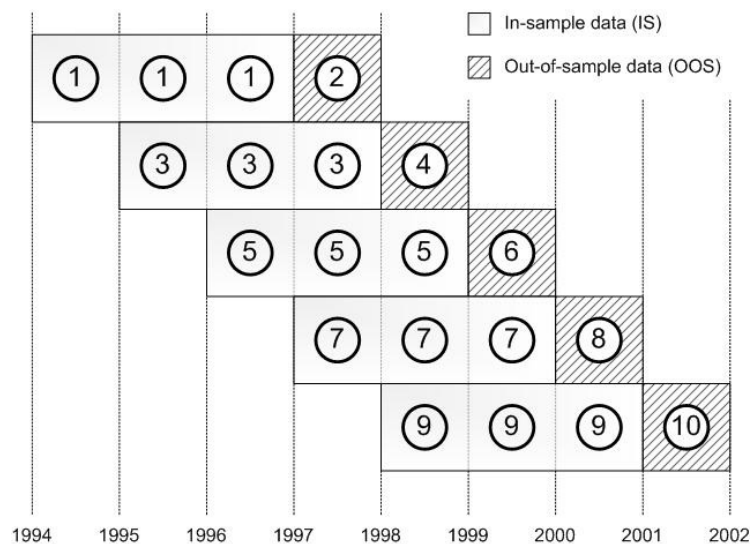

Figure 6. Data segments in walk-forward analysis

Example of results of WFA is shown at the Fig. 7.

Mode	Begin	End	No.	Net Profit	Net % Profit
IS	1.1.1994	29.12.2000	94	-977.08	-9.77
OOS	29.12.2000	29.12.2002	1	6625.93	66.26
IS	1.1.1996	29.12.2002	10	9244.14	92.44
OOS	29.12.2002	29.12.2004	1	-1786.95	-17.87
IS	1.1.1998	29.12.2004	4	4490.74	44.91
OOS	29.12.2004	29.12.2006	1	2917.93	29.18
IS	1.1.2000	29.12.2006	4	21548.90	215.49
OOS	29.12.2006	29.12.2008	1	7092.47	70.92
IS	1.1.2002	29.12.2008	71	30775.66	307.76
OOS	29.12.2008	29.12.2010	1	2241.06	22.41

Figure 7. Results of walk-forward analysis

1.6. Commentary on Optimizing Trading System

The obtained results and optimization procedure serve to improve efficiency of trading system. However, there is always a risk of over-optimization. This is often the case of trading systems using combination of multiple indicators at the same time. The golden rule of ATS design is to follow simple straightforward idea and maintain system as much transparent as possible. Usual problem of beginners lies in creation of trading system where multiple ideas are working against each other. In this context, it is worth noticing that profitability of trading system is strongly related to market – idea suitable for one market may not be working well in another. Also, backtesting results are usually slightly better than reality and it is a good practice to reduce "backtested" profit of trading system about 15-20% to get more realistic outcome.

2. Testing of Selected Exit Strategies

Every trading strategy, automated or manual, has two important phases – entry and exit, i.e. opening and closing position. Market entry refers to start of trade while market exit refers to trade ending. Timing of exiting is more important than entry [3] or [6], because bad beginning can be corrected by good closing but not vice versa.

In order to achieve precise timing and protection against major losses, several standard exit strategies can be used. Profit target, maximum loss and trailing stop strategies will be used here to demonstrate impact of application of such features into ATS design.

2.1. Risk Management and Exit Strategies

Basic tool used in most exit strategies (possibly with modifications) is stop-loss order (SL). SL creates automated exit order on user-defined price level and when this price is breached (no matter from which direction, principle is the same for long and short positions), position is closed automatically. It is highly recommended – most experts

would say mandatory – to use SL (or other protection tools) in every trade. When position is opened, SL order is usually placed several ticks in direction of loss. The idea is to accept small loss instead of significant one. In principle, losses cannot be avoided, but with application of risk management exit strategies, it may be reduced to necessary minimum.

Notion of risk management refers to variety of tools and rules used by trader to protect himself / herself from financial losses. Since it is not purpose of this text to explain this area in detail, more information on this subject may be found in literature [2], [1], [4] or [6].

In following tests, three exit strategies and their combination will be used to demonstrate impact of application of such tools on trading system`s performance. In order to allow comparison, use of trading system without exit strategy will be included as well. Trading system will be again used in simplified version for transparency and easy understanding. Trading system itself is not the matter of interest here.

2.2. Indicator Stochastics

Tests will be performed on historical data using simplified version of trading system using Stochastics indicator for placing entry and exit orders. Stochastics indicator is oscillator. According to [4], it is based on momentum and uses support and resistance levels. Indicator tries to predict price turning points by comparing closing price to its price range. It is different from similar indicators (like Relative Strength Index - RSI or Momentum - MOM) because it uses not only closing prices but also price high and low.

There are three components used in stochastic measurement - %K, %D and %D-slow. %D may be used separately, but also in combination with %D-slow. For today`s values (*today, t*), following formulas are used [4]:

$$starting\,\%K = 100 * \frac{C_t - L_t(5)}{R_t(5)} \tag{6}$$

$$\%D = "\%K\text{-}slow" = \frac{\%K_t + \%K_{t-1} + \%K_{t-2}}{3} = \frac{(\sum_{i=t-2}^{t} \%K_i)}{3} \tag{7}$$

$$\%D\text{-}slow = \frac{(\sum_{i=t-2}^{t} \%D_i)}{3} \tag{8}$$

C_t stands for today`s closing price, $L_t(5)$ is price low for last 5 days and $R_t(5)$ is price range for last 5 days (highest high minus lowest low) including today`s values.

2.3. Profit Target

First exit strategy is called Profit Target (PT). The principle of this exit strategy lies in closing position after reaching pre-defined level of profit. It is common for a price to behave in repeating patterns and high of price peak may therefore be predicted. PT is usually placed near the peak (or bottom in case of short position) and position is closed before price reaches its turning point.

The motivation to do this is reduction of emotions in trading process, see [2] or [3], for more information on this important topic. Trader does not have to watch price all the time, but precisely follows rules. This helps to keep distance and be emotionally more "stable". Also, price peak is difficult to work with – a position is, in most cases, closed prematurely or late. PT helps to clarify the situation.

2.4. Maximum Loss

Principle of Maximum Loss (ML) is simple. After reaching pre-defined amount of loss, position is closed. This stop is executed when the low price for the given day drops below the stop level that can be given as a percentage or point increase from the buying price.

2.5. Trailing Stop

Each time a position value reaches a new high, the trailing stop order is placed at higher level. When the profit drops below the trailing stop (TS) level, the position is closed.

2.6. Test results

Symbols listed at the Tab. 5 will be used in presentation of results:

Table 5. Used symbols and their interpretation

Symbol	Meaning
CZ9	Corn
OZ9	Oats
WZ9	Wheat
MTDD	Maximum trade drawdown
MSDD	Maximum system drawdown
Exp.	Exposure
# Trades	Number of trades

There are 3 markets for testing (corn oats and wheat) presented here. This is complete GRAINS segment of commodities. There are 5 groups of results (always with 3 best results), for more details see [9]:

- Basic settings – no special exit strategy.
- Maximum loss
- Profit target
- Trailing stop
- Combined approach – combination of ML, PT and TS.

Historical data are used from Dec 1997 to Dec 2009. Used symbols are explained in Tab. 5. Trading system has similar parameters to system used for demonstration of optimization procedure described at the beginning of this chapter – starting capital 10 000 USD, only long positions are considered, commissions (and other transaction costs) are not included here.

Test results are presented in Tab. 6 (corn), Tab. 7 (oats) and Tab. 8 (wheat):

Table 6: CZ9 (corn)

#	Net Profit	Exp. (%)	MTDD	MSDD	# Trades
	BASIC SETTINGS				
1	39 274,65	49,21	-4 039,44	-9 618,53	483
2	34 898,37	49,61	-3 242,19	-9 923,78	528
3	28 165,17	49,37	-3 036,44	-6 719,14	493
	MAXIMUM LOSS				
1	43 567,48	47,34	-3 868,20	-8 759,48	528
2	37 467,83	47,03	-3 891,32	-10 842,50	483
3	35 507,39	47,09	-3 452,30	-7 517,09	493
	PROFIT TARGET				
1	20 464,71	28,61	-1 086,01	-5 473,95	343
2	17 844,40	28,84	-2 051,68	-4 953,34	341
3	14 355,20	36,54	-1 854,13	-5 046,67	528
	TRAILING STOP				
1	27 035,78	40,41	-2 588,87	-4 893,73	528
2	26 799,59	39,28	-2 597,94	-6 567,55	483
3	20 105,79	39,97	-2 104,45	-4 146,07	514
	COMBINED APPROACH				
1	21 911,90	22,16	-1 090,46	-3 565,33	329
2	18 875,09	19,24	-1 649,23	-3 198,42	261
3	18 846,57	18,81	-1 765,39	-2 919,71	261

Table 7: OZ9 (oats)

#	Net Profit	Exp. (%)	MTDD	MSDD	# Trades
	BASIC SETTINGS				
1	30 127,81	32,76	-5 667,07	-7 285,54	485
2	29 157,44	37,43	-2 965,45	-5 528,50	349
3	28 741,06	34,58	-2 965,45	-8 613,52	477
	MAXIMUM LOSS				
1	29 043,51	35,58	-2 872,05	-5 455,10	349
2	28 381,82	32,23	-5 613,05	-7 544,36	485
3	26 639,80	34,12	-2 932,50	-8 392,20	461
	PROFIT TARGET				
1	48 768,25	20,67	-2 092,20	-4 504,88	469
2	48 058,34	20,59	-2 189,78	-4 541,88	477
3	45 454,97	21,23	-2 337,97	-5 559,59	488
	TRAILING STOP				
1	29 152,42	27,55	-2 932,50	-5 346,52	485
2	28 219,44	27,58	-1 531,72	-6 345,72	488
3	27 689,67	29,15	-2 932,50	-4 699,79	461
	COMBINED APPROACH				
1	37 609,22	19,21	-2 899,32	-4 379,73	485
2	35 989,46	20,49	-1 426,90	-4 406,02	461
3	35 567,83	19,40	-1 744,36	-4 746,38	488

Table 8: WZ9 (wheat)

#	Net Profit	Exp. (%)	MTDD	MSDD	# Trades
			BASIC SETTINGS		
1	10 295,36	49,34	-1 945,63	-9 933,34	506
2	9 658,38	50,00	-4 528,67	-14 758,99	213
3	9 179,33	50,14	-4 603,12	-16 951,15	253
			MAXIMUM LOSS		
1	10 010,90	44,58	-1 820,35	-8 768,80	501
2	8 253,51	45,24	-1 677,41	-8 097,14	497
3	7 862,20	43,52	-1 576,44	-6 436,88	451
			PROFIT TARGET		
1	15 156,35	27,06	-1 960,91	-6 931,24	406
2	14 529,77	31,61	-3 234,30	-5 729,68	519
3	14 449,02	31,30	-2 064,09	-5 423,72	511
			TRAILING STOP		
1	421,02	29,95	-777,92	-3 669,41	537
2	218,93	29,07	-710,59	-2 634,25	501
3	-639,22	13,82	-801,22	-3 826,08	236
			COMBINED APPROACH		
1	10 738,52	21,48	-1 092,29	-2 729,80	501
2	9 994,57	22,70	-1 489,72	-4 054,51	537
3	6 741,73	17,35	-677,11	-4 954,11	412

2.7. Interpretation of results

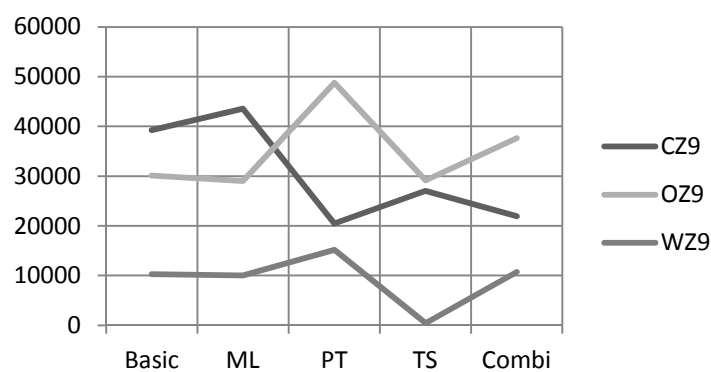For easier comparison, results are presented in five charts according to respective system parameters, see Fig. 8-12.

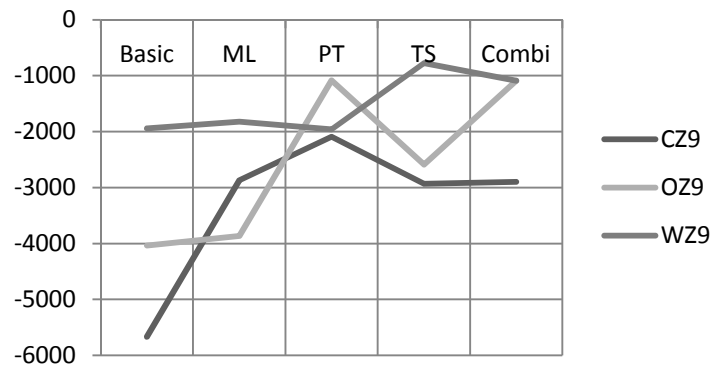**Figure 8.** Net profit – comparison of CZ9, OZ9 and WZ9 markets

Figure 9. Maximum trade drawdown – comparison of CZ9, OZ9 and WZ9 markets
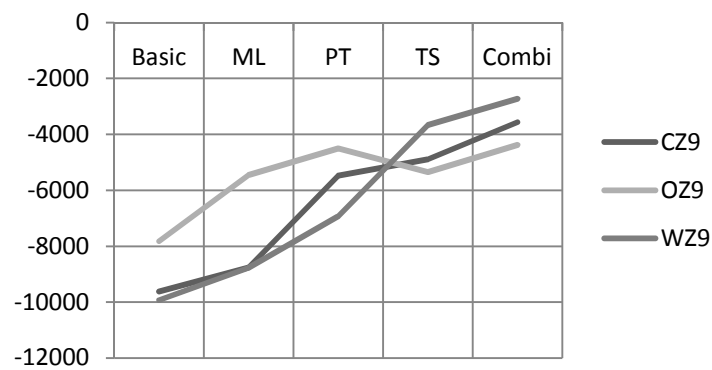

Figure 10. Maximum system drawdown – comparison of CZ9, OZ9 and WZ9 markets
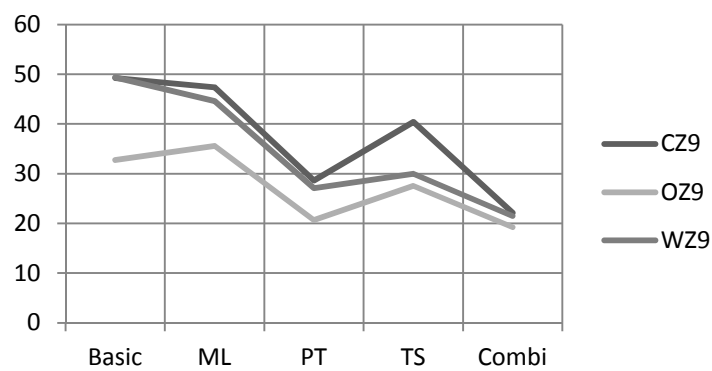

Figure 11. Exposure – comparison of CZ9, OZ9 and WZ9 markets
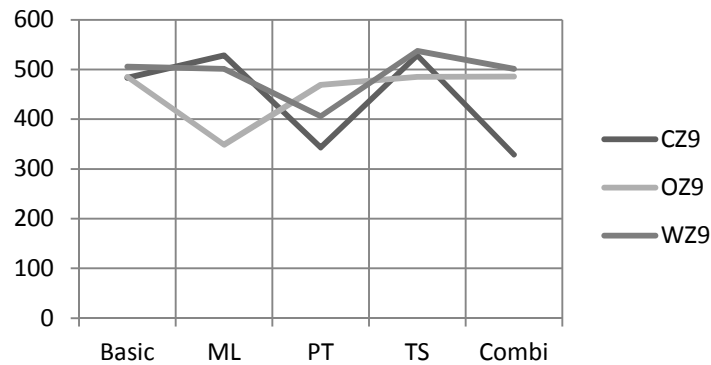
Figure 12. Number of trades – comparison of CZ9, OZ9 and WZ9 markets

Poor performance (*net profit*) in wheat market using trailing stop strategy is probably result of inappropriate tool (indicator Stochastics is ineffective here). Test results leads to conclusion that more aggressive trading takes place before application of exit strategies. This is confirmed in high *exposure* and *drawdown* parameters. Although original assumption was that *net profit* will be reduced by application of exit strategies, this was not confirmed. Conversely, some exit strategies manifested higher *net profit* than basic settings. Most significant impact of exit strategies is shown in reduction of exposure and drawdown parameters. This leads to conclusion that implementation of exit strategies leads to stabilization of the system.

3. Conclusion and Future Work

This chapter provided overview of optimization procedure and shown impact of implementation of exit strategies in trading system. There are many possibilities for future research:

- testing more market for further validation of results,
- testing with different indicators,
- implementing more complex model of system (including transaction costs),
- non-constant settings of parameters,
- testing other exit strategies,
- etc.

ATS are used with maximum potential only when user is aware of all underlying principles and if he/she is able to perform trading even without ATS support. ATS is a logical extension of trader`s abilities – can help with tasks that are routine and repeating and its application eases workload. ATS may not be taken as easy way to generate money. In all aspects, use of ATS bears the same risk as manual trading. Usual cause of skepticism in matter of ATS use is induced by inappropriate expectations, misconception of principles and lack of education in this area. In spite of all of its weaknesses, ATS represent modern trend in trading and its further spread may be expected in the future.

Acknowledgements

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