An Evolutionary Approach to Define Investment Strategies based on Macroeconomic Indicators and VIX Data

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ABSTRACT
This paper describes a new evolutionary approach to stock market forecasting. This approach can successfully forecast S&P500 Index's Futures price evolution using mainly Macroeconomic Indicators from different regions (United States of America, European Monetary Union and Germany) and measuring its impact using Index's volatility. In addition to the Macroeconomic data time series, MAs and VIX were used. In order to validate the results, the obtained strategies, based on Macroeconomic Indicators, were compared against the B&H and MA based strategies in the period between 2010/01 and 2011/09 with the S&P500 Index Futures, showing outstanding improvements in performance.

Categories and Subject Descriptors
I.2.M [Artificial Intelligence]: Miscellaneous

General Terms
Algorithms, Economics, Experimentation

Keywords
Computational Finance, Macroeconomic Indicators, Technical Indicators, Evolutionary Computation, Investment Strategies

1. INTRODUCTION
Capital Markets have become extremely popular among academic community, particularly, in Machine Learning and Soft Computing areas where the impact of various factors and forecasting of future prices are investigated using a variety of algorithms and Fundamental and/or Technical Analysis. The Soft Computing methodologies have been applied to market forecasting and trading rules, and in many cases have demonstrated better performance than competing approaches like standard econometric models [1-5]. This work proposes a new evolutionary approach to stock market forecasting by putting together the ability of evolutionary algorithms to find optimal strategies with in deep market information embedded on Macroeconomic Indicators and selected Technical Analysis Indicators such as the Volatility Index (VIX).

2. METHODOLOGY
The proposed methodology relies on the implementation of a GA optimization kernel adapted to the exploration of stock market investment strategies based on Macroeconomic Indicators. Particularly, this work optimizes the combination of linear variables which their sum of impacts is highly correlated with the index, in order to forecast the evolution of the prices and, therefore, allow the discovery of profitable strategies. Besides using macroeconomic variables, it is also proposed to use moving averages with the help of which it is planned to choose the right moments of entry and exit in the market. In order to avoid losses at times when macroeconomic news are ignored by investors in a climate of fear and uncertainty, the Volatility Index (VIX) will be used. The chromosome structure is illustrated in Figure 1. The list of parameters and ranges considered during the optimization process is presented in Table 1. Then, the achieved values are used by a voting system to decide what action to take. The fitness function uses a ratio between Profitability Index (PI) and Maximum Drawdown (MDD) to rank the solutions during the evolutionary process. Finally, the algorithm terminates the search when reaching a number of generations or when no improvement of the fitness is achieved for a certain number of iterations.

Figure 1. Chromossome Structure

Table 1. Parameters' Description and Ranges of Values

Parameter	Description	Range of values
MEV Collection	Combination of different MacroEconomic Variables.	Any combination of available variables.
MA1, MA2	Moving average used by the hypothesis.	10, 20, 30, 50, 100 and 200.
Decay	Time that the impact of a MEV takes to decay.	Between 1 and 8 weeks (expresses in days or days and hours).
VIX Limit	The limit below which the market is consider being calm and rational.	Can take the values 20, 25, 30, 35 and 40 for historical reasons.
Threshold	Threshold of confidence.	Multiple of 0.1 between 0 and 1.
MEV Impact Sum Weight	Importance of the MEV Impact Sum.	Integer from 0 to 10.
MEV Impact Sum Derivative Weight	Importance of the MEV Impact Sum Derivative.	Integer from 0 to 10.
MA1 Weight, MA2 Weight	Importance of the MA1.	Integer from 0 to 10.

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3. RESULTS

All the tests were performed with the training period from 2007/01 to 2010/01 and testing period from 2010/01 and 2011/09.

3.1 Case Study - MAs, VIX and MEVs' Optimization with Linear Contribution and Simple Decay

This case study was based on the preliminary tests, where promising results were obtained using mostly Macro Economic Variables (MEVs) without doing any optimization. This case study in an attempt to improve the results by the optimization of MEVs with linear contribution and simple decay. Since the impact of macroeconomic variables varies over time, several tests are also performed using a sliding window (SW) optimization. Figure 2 shows the evolution of the best strategies discovered during the optimization process clearly beating the B&H reference.

3.1.1 Test A – 3 years Training and Continuous Investment

The tests in this case study were performed using Profitability Index Maximal Drawdown (PIMDD) evaluation function and the parameters from Table 2. All the solutions found (see Table 3) in this case study significantly overcomes the benchmark and are very similar, using 50 days MAs, VIX limit of 40 and 18 days decay. Also, all the strategies use Gross Domestic Purchases Price Index (MoM usually published jointly with Gross Domestic Product Annualized, Real Personal Consumption Expenditures QoQ), Housing Starts (MoM, usually published jointly with Building Permits), ECB Interest Rate Decision and Consumer Price Index (MoM, usually published jointly with Consumer Price Index Ex Food & Energy). Once again all the investment decisions are made using only Macroeconomic Indicators' Impacts and MA of 50 days is only used to close short positions when the volatility is too high.

3.1.2 Test B – Sliding Window Training and Investment

In this case study were performed several test using training and testing sliding windows of 1,2 and 3 years, 3, 6 and 9 months respectively (75% training and 25% testing) and the parameters of Table 2. The best results (see Table 3) of this case study were obtained using 3 years training and 9 months investment periods (longest periods), suggesting that to detect patterns of behavior, the algorithm needs larger amounts of data. The VIX Limit is the only constant parameter and it is equal to 40. During the simulation, solutions using sub-sets of Macroeconomic Indicators and fewer transactions achieved better results. Using a sliding window was possible to obtain better results that lead us to the conclusion that the impact of macroeconomic variables varies over time and that it is possible to discover the most relevant factors using GA optimization.

Table 2. Case Study Input Parameters

Input Parameter	Value (Test A)	Value (Test B)
Threshold Limits	0.1	0.1
MEV Sum. Weights	2	2
MA Weights	0,1 and 2	0

Table 3. Case Study Results

Case	Result	PI MDD	Tr.	PI	B&H	PI/year	B&H/year
T B	**Min.**	0,100	38	1,456	1,075	1,253	1,045
	Max.	0,100	38	1,456		1,253	
	Average	0,100	38	1,456		1,253	
T A	**Min.**	0,094	48	1,013		1,008	
	Max.	0,173	64	1,657		1,354	
	Average	0,129	52,4	1,377		1,210	

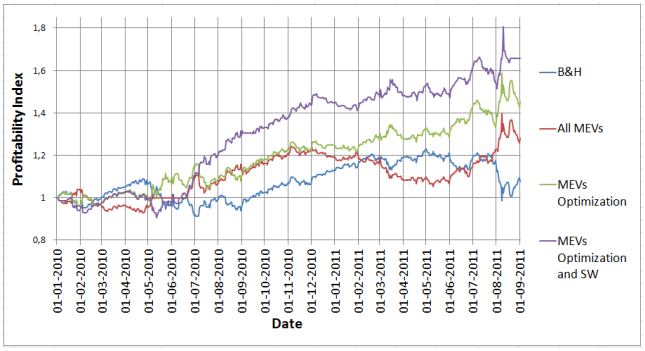

Figure 2. Best Strategies vs. B&H

4. CONCLUSIONS

The most important conclusion of this work is that the Macroeconomic News' Impacts can be successfully measured using the market's volatility associated to its release, that in the case of this work was measured with the minutely variations of the S&P500 Index Futures'. The Macroeconomic Indicators' impacts, measured this way, can be successfully used in the short term forecasting, despite the fact that usually it is considered that Macroeconomic analysis considers factors affecting the long-term level. The developed application made an excellent profit (average of 25% per year) in a simulation exercise using almost exclusively Macroeconomic Indicators.

5. REFERENCES

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