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Financial Markets 2.0: Modern Risk Management in times of Machine Learning

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THE ARTIFICIAL INTELLIGENCE METHODS IN THE ASSET MANAGEMENT INDUSTRY

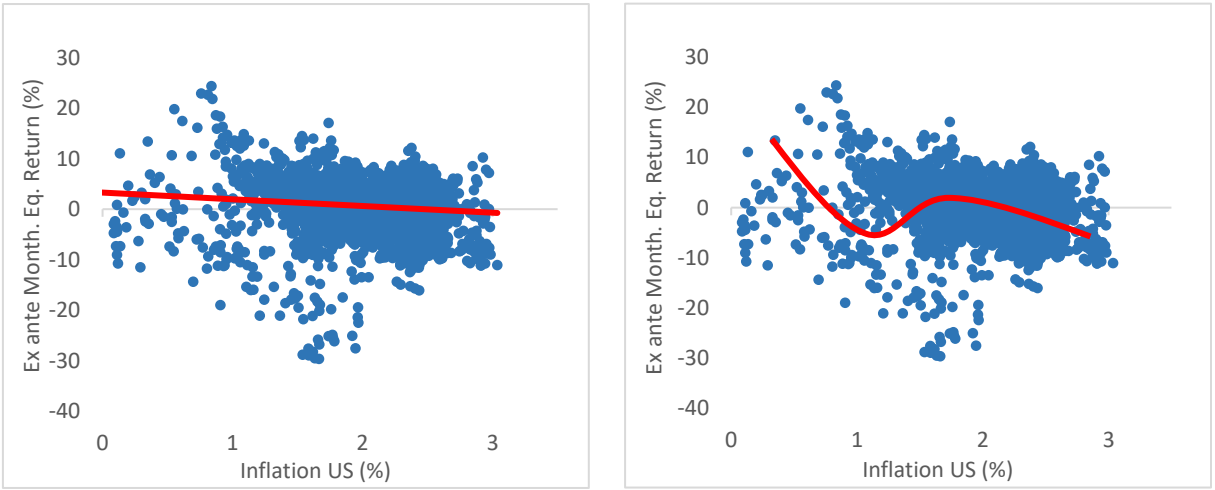
The launch of ChatGPT by Open AI at the beginning of the year has highlighted **the revolutionary character of artificial intelligence methods**. While artificial intelligence has already been present through translation services, digital assistants in customer chats or its application in image and speech recognition in medical science, ChatGPT has further revealed the breadth of skills and abilities artificial intelligence can take in our everyday life.

In the asset management industry, adopting Machine learning techniques can **help to optimize the investment process and provide benefits to risk management**. **Machine learning (ML)** as a subfield of Artificial intelligence (AI) encompasses **algorithms and models that can learn complex patterns from data to make predictions**. Hence, the ML methods can offer completely new insights into capturing and evaluating capital market drivers.

As data determines the structure of the ML model to a greater extent than in the case of traditional quant models, they can model complex capital market relationships more precisely and respond dynamically to changes in the market environments. However, as ML methods are demanding with regard to data and computing power, they have for a long time not lived up to their full potential, given that first methods have already been developed in the 1980s.

FIGURE 1: Linear vs. Non-Linear Models

The figure plots the ex-ante monthly equity returns (in%) versus the US Inflation rate (in %). The left plot shows the fit of a linear model to the provided data, while in the right figure a non-linear fit is chosen.



Source: La Francaise Systematic Asset Management GmbH; Bloomberg; Own calculation, MSCI USA Index, US Breakeven inflation 10 year (06/2006 – 03/2023)

For the asset management industry, the solution to these limitations was resorting to a linear world, utilizing economic models like the Capital Asset Pricing Model or the Arbitrage Pricing Theory, in which the return and the risk of an asset depends linearly on a set of factors. While the interpretability of such models is easy, economic reality shows that relationships among variables are inherently non-linear in nature and that many non-linear economic relationships are not properly captured by traditional econometric models. Figure 1 shows an example of such a relationship, in which monthly

US equity returns are plotted against the US breakeven inflation rate. Clearly a non-linear model is superior in capturing the underlying relationship.

Modern times risk management tools thus need to utilize methods that **capture these complex nonlinear relationships between the input data and the trading signals, as well as include potential interaction effects among them**. At the same time, the system needs to acknowledge that **behavioural factors continue to play a crucial role** in the state of the market. One of the most well documented factors – the momentum factor – builds upon the observation that market participants behave irrationally, following herding and overconfidence patterns, and thus creating excess return possibilities.

As a risk manager with a long-standing breadth of experience, these observations led to the development of our **Advanced Data Operating Risk Agent**, called **ADORA**. The system **combines state-of-the-art supervised machine learning models to uncover existing relationships among broad data sources while accounting for a behavioural component including trend- and volatility analysis**.

While the ADORA System solves the non-linearity problematic, it also acknowledges that simply using price data is detrimental when training machine learning methods, given their low signal to noise ratio. In fact, using such data in complex statistical models can easily lead to over fitting and inferior out of sample performance. The system thus **employs a global set of over 500 different indicators, carefully selected and empirically validated among price, fundamental, macro and sentiment data**. Finally, with its **global focus** the system recognizes that globalization has led to stronger cross-border economic linkages and increased financial integration between economies and asset classes. Macroeconomic shocks in one country are increasingly likely to spread to other countries and the investor thus cannot simply rely on knowing the developments in his preferred market, but also needs to monitor major developments in other economies.

STATE OF THE ART MACHINE LEARNING METHODS

Diving deeper into the functionality of the ADORA system, the machine learning component follows **a model pooling approach, in which a subset of the total of 12 available models is evaluated**. Among them the considered models include algorithms like Support Vector Classifiers, Logistic Regression with a Regularization Penalty, Decision Trees, Neural Networks or Extreme Gradient Boost Classifier (XGBoost). The model pooling approach acknowledges that no model always beats any other model in every scenario. In fact, each model comes with its own strengths and weaknesses and **combining them allows to balance out these characteristics to arrive at a more robust forecast.**

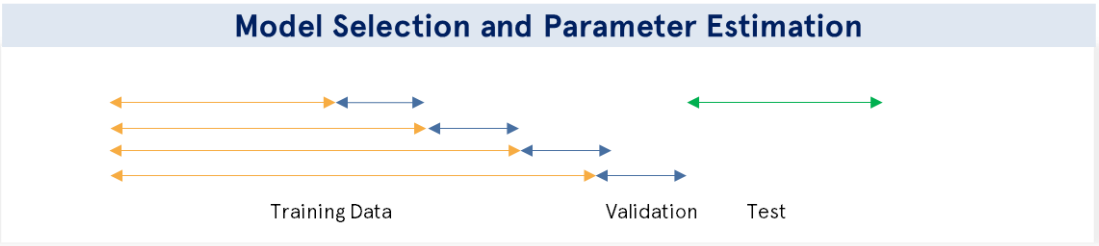
The final model generates a risk indicator defined as the probability of significant loss, from which the equity investment exposure for the overlay system is derived.

The **calibration or training of the ML model** is done by the Portfolio Managers and plays an integral part, integrating the human experience into the model building process. In fact, we understand the application of ML models as a technique to uncover the interaction among input variables in higher dimensions utilizing as a baseline the experience of a seasoned investment professional. This selection and calibration step thus represents **the true value add that is performed by the quant researcher**, as it demystifies the black box character of ML methods and adds a layer of transparency, making the decision recallable regarding the input data and algorithms used.

So, each labelled input given to the ML model indicates whether a market has been in a "normal" state or in a state of "distress" according to Portfolio Managers. The set of ML models is then trained and validated using input data from 2007 to 2016 as shown in the Figure 2. The aim is to select those models that show the best accuracy on the rolling validation sets - the performance on previously unseen data - while at the same time having the lowest model variance.

FIGURE 2: Model Selection and Parameter Estimation

The figure shows the data split for the model selection and parameter estimation steps, utilizing training and validation data from 2007 – 2016 and a testing set from 2017 – 2022.



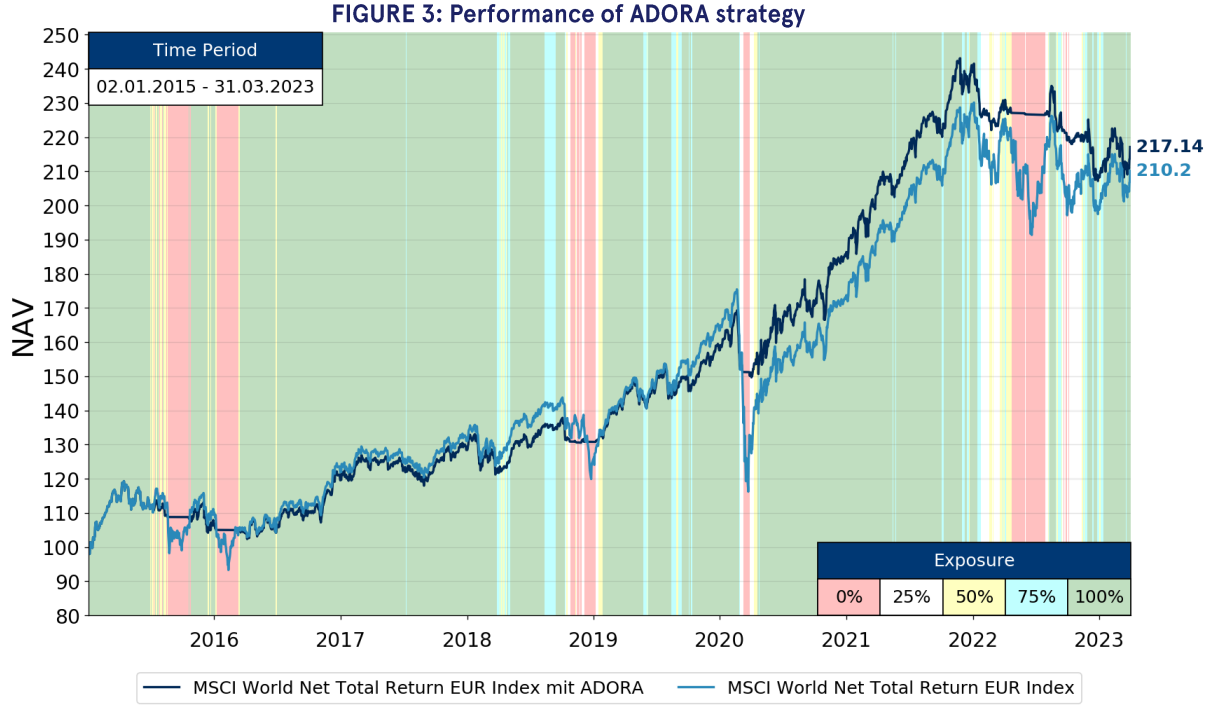
Source: La Francaise Systematic Asset Management GmbH; Own illustration

PUTTING THE PIECES TOGETHER

Each crisis has their own character, duration and means of recovery. It is thus necessary that a modern-day risk management tool shows the **flexibility to adjust to various stress scenarios**. It also ensures that the model is not overfit to individual historical situations.

Figure 3 shows the performance of the ADORA model utilizing the MSCI World Net Total Return EUR Index over a period from January 2015 to March 2023, comparing it to a classic buy-and-hold strategy.
As evident from the figure, the system considers five different investment states, whereas the generated signal allows to not only adjust the exposure gradually, but also to dynamically react to fast drawn downs and recoveries. Over the complete time period, the ADORA system reliably reduces the losses in bear markets, achieving the most important requirement for a risk management. At the same time, it allows to reduce the cost associated with a classical overlay strategy, by showing a similar performance as the buy-and-hold strategy, even yielding a superior risk adjusted performance.

FIGURE 3: Performance of ADORA strategy



	YTD (30/3/2023)	2022	2021	2020	2019
MSCI World Net Total Return EUR Index with Adora	4.4%	-9.1%	20.0%	19.2%	18.7%
MSCI World Net Total Return EUR Index	5.7%	-12.4%	23.2%	6.3%	27.2%

	Performance since inception*	Annual Performance	Annual Volatility	Sharpe Ratio	Max Drawdown
MSCI World Net Total Return EUR Index with Adora	117.1%	9.9%	11.1%	0.91	-14.8%
MSCI World Net Total Return EUR Index	110.2%	9.4%	16.6%	0.58	-33.8%

* Since 01/2015.
Source: La Francaise Systematic Asset Management GmbH; Bloomberg; Own calculation based on MSCI World Net Total Return EUR Index; Past performance is not indicative of future performance.

SUMMARY

The growing complexity of financial markets requires an agile risk management system that integrates broad data sources, while considering complex non-linear relationships and interactions in financial data. To achieve that, our ADORA system utilizes the state-of-the-art machine learning models and combines them with traditional well-proven behavioural model. Finally, the resulting model can detect endogenous shocks early by dynamically responding to the changing market environment. Compared to a buy-and-hold strategy, the empirical analysis achieves significant loss reduction and an improved risk-return ratio.

Main risks: Risk of capital loss: The investor is notified that his capital is not guaranteed and therefore might eventually not be returned.
Model risk: The model may not always behave as expected. Therefore, the model cannot guarantee to reduce losses in value.
Risk associated with derivatives: The model uses derivatives. These are financial instruments whose value depends on the underlying asset. Minor fluctuations in the price of the underlying can lead to significant changes in the price of the derivative.

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