Industry 4.0 meets Asset Management

Diversification, Forecast, and Risk Management via Big Data and Artificial Intelligence

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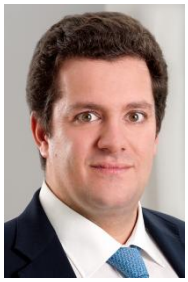

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From Industry 4.0 to Quant 4.0

The barriers came down and the fourth industrial revolution is already here. Revolutions are fast, turbulent and devastating. And there is no way back.

Europe has already experienced three industrial revolutions. The first increased productivity through the use of steam power and the development of machine tools. The second exploited electricity and serial production, and the third (and most recent) brought automation by means of electronics and IT.

The fourth industrial revolution, the so-called "Industry 4.0", is already on its way[1]. This time the breakthrough is being produced by synergy between the internet, big data analysis and artificial intelligence. As a result, "stupid" robots that substituted workers during the last revolution are becoming intelligent, which means they are able to modify their behavior and interact. The internet is combining with smart machines and systems production to create an advanced network. The world is evolving towards a huge information system. This system dynamically connects manufacturing processes with the supplier and final customer networks, allowing tailor-made production that matches client requirements.

Implementation of Industry 4.0 in the asset management sector implies the complete automatisation of the cycle - defined by online data capture, forecast, and portfolio definition and construction (See Figure 1). These tasks involve interaction between the three basic technologies of this new industrial revolution: collection of raw market data from the internet, the conversion from data to information through big data analysis, and the processing of such information to carry out predictions and take investment decisions by means of artificial intelligence algorithms.

In this scenario, the independent quantitative asset manager GET Capital AG has made a firm commitment to fully implement the Industry 4.0 paradigm in its investment strategy. The firm refers to it as "Quant 4.0". Such an initiative involves technological, scientific, and cultural challenges (See "Quant 4.0 production plant: Sensors, brain, and muscle"). A Quant 4.0 asset manager must possess massive IT-infrastructure in order to store and analyse large amounts of data in real time. Highly qualified mathematical specialists are needed in order to develop artificial intelligence algorithms that transform data into valuable information used to make decisions. And last but not least, strong involvement from management is a fundamental requirement in order to overcome the cultural barriers associated with the transition to Industry 4.0 standards.

[1] "Industry 4.0 – The new Industrial revolution – How Europe will succeed" Think Act. Web. 03. April 2014

Quant 4.0 production plant: Sensors, brain, and muscle

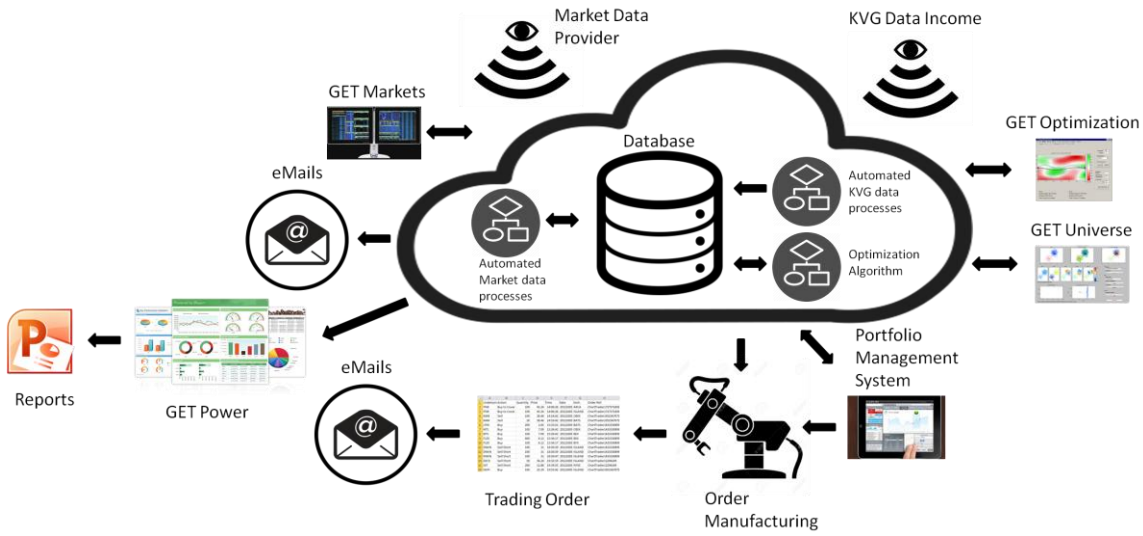

Figure 1: Quant 4.0 factory.

An Industry 4.0 factory is an advanced network that allows the automation and setup of the whole production cycle. Its main components are

- Sensors: Devices that measure and send information pertaining to the environment.
- Big Brain: Component that receives, stores, and processes the information in order to define the production guidelines.
- Intelligent "workers": Devices that receive instructions and send information from/to the Big Brain, in order to physically manufacture the final product.

The Quant 4.0 infrastructure permits a full automation of the whole investment cycle of GET Capital. The securities and portfolio data is collected programmatically from the Bloomberg and custodian terminals, respectively. The Big Brain stores this data and uses its computing cluster to calculate (in parallel) key portfolio and securities measures such as portfolio performances, return and risk estimators, security trading permissions, transaction costs, etc. These parameters are inserted in the daily portfolio optimisations that run distributed in the Big Brain cluster for every fund under management. Finally, software "manufactures" the trading orders that implement the optimal portfolio allocations and sends them to the brokers.

In addition, a set of graphical user interface (GUI) is able to set up every step of the investment process, and therefore to customise the final portfolio according to client requirements. Specifically, these GUIs insert untracked securities in the system, define and implement new investment universes, modify the portfolio optimisation constraints, create ad hoc trading orders, and permit the visualisation and reporting of portfolio composition and performance.

Overall, the modularity, automation, and flexibility of the Quant 4.0 production line imply a reduction of operational costs, scalability with no additional expense, and tailor-made product customisation.

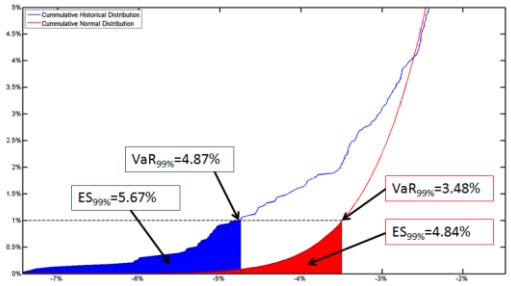

Figure 2: Cumulative Return Distribution of DAX 30. The blue curve represents the historical cumulative return distribution of DAX. The red curve corresponds to the normal approximation of the DAX returns. The fat tails play a fundamental role in the risk estimation. The normal approximation underestimates the risk due to its fast decaying tails. In addition, the expected shortfall (ES) - with a 99% confidence interval - considers specifically the fat tails in the risk measurement and shows that the Value at Risk (VaR) (which does not take extreme events into account) underestimates the potential losses associated with a DAX investment

Monitoring raw material: Real time data collection and advanced return/risk forecasts

The first step in any Industry 4.0 process is to monitor - in real time - the raw materials, and to anticipate their future behaviour. For Quant 4.0 this means the automatic collection of market data and the calculation of risk and return forecasts. GET Capital screens thousands of securities daily. This information is then used to carry out risk and return predictions for every security under analysis.

The financial crisis of 2008 fueled the emergence of extremely volatile market regimes with different timespans and sudden losses. The conservative asset management industry held on to classical moving average return estimators, with their underlying assumption of regimes with fixed lengths and low volatility. This poor decision produced dramatic losses for institutional clients.

GET Capital uses machine learning technology (See "Machine learning for return estimation and investability signalisation") to construct a set of estimators aimed at predicting market performance over different timescales, e.g., weekly, monthly or yearly. Such estimators base their predictions on automatic detection of the current market regime over the scale under analysis. In contrast to moving averages, these regime-based estimators are able to adapt the forecasted regime length in qualitatively different market scenarios. That is, for stable markets the estimators use long time windows to calculate the return. By contrast, during crisis events the estimators react by applying short time windows. The results of the forecasts for different timescales are then used as inputs in machine learning classifiers and regressors (See Figure 3). As a result, every market is identified as investable or uninvestable, and its return for the next investment period is predicted.

Similarly, volatility-based risk measurements underestimated the market collapses during the financial (or the euro) crisis, due to their inability to capture losses associated with extreme events. GET Capital applies state of the art financial mathematics to use the expected shortfall risk measurement to evaluate the market risk (See Figure 2). Thus, the expected shortfall at q percent is the expected return of the security in the worst q percent of the cases. Therefore, in contrast to the volatility or the Value at Risk, the expected shortfall takes into account the risk associated with extreme events and is able to provide a realistic measurement of the losses that an investor can face during crisis scenarios.
The combination of internet, financial mathematics, and artificial intelligence technology involved in the massive data prospection and the new risk and return estimators, respectively, produces reliable and real-time forecasts for a vast set of securities. This finally permits the portfolios to profit from long-term volatile positive markets, and to reduce the drawdown associated with crisis scenarios.

Machine learning for return estimation and investability signalisation

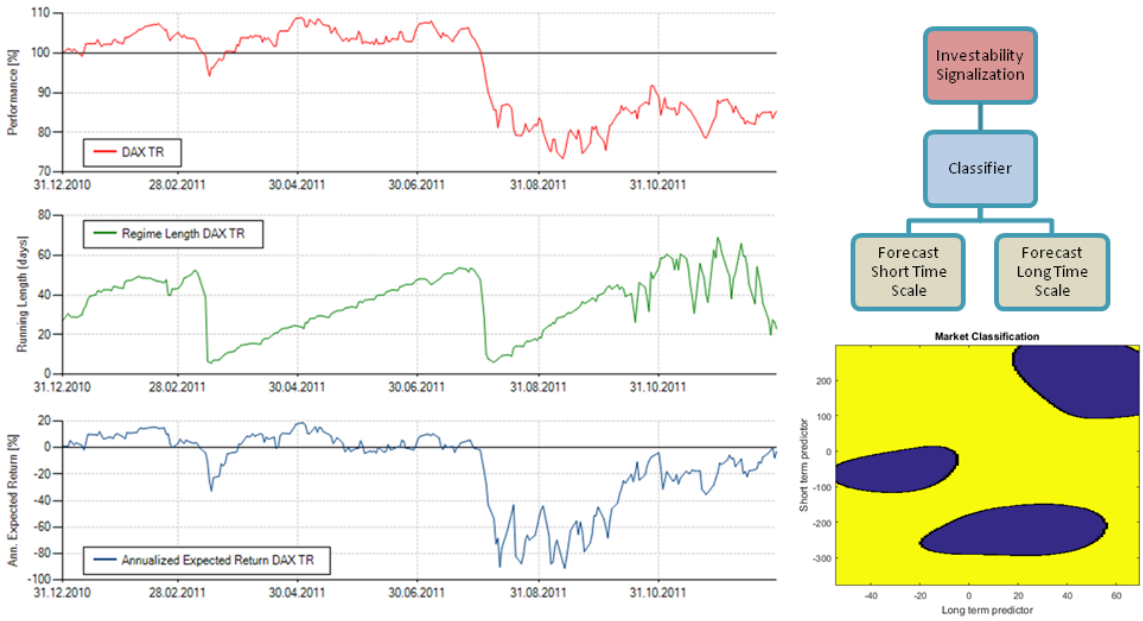

Figure 3: Key elements of the return forecasting and investment signalization.

The top-right panel shows the fundamental role played by machine learning in the GET Capital investability signalisation. Specifically, advanced models forecast the security return for different timescales (in figure 3, shown as just long and short for the sake of clarity). Then, these estimations are combined by a classifier that finally allows or forbids the investment in such a security.
Bayesian regime-switching models calculate the security returns for different timescales, e.g., daily, weekly, monthly or yearly. Such predictions rely on the inference of the security regime over the scale under analysis. The upper, middle, and bottom plots depict the performance, regime length, and return estimations for the daily evolution of DAX in 2011, respectively. It can be observed that the Fukushima nuclear disaster (11 March 2011) triggers a new negative regime. The reaction of the estimator is quite fast, needing just two days following the accident to detect the regime and forecast a significant negative return. This regime then evolves until the emergence of the euro crisis in August 2011. Massive losses in DAX provoke the quick detection of a new regime with extreme negative return expectations. The negative regime persists until the end of the year: it is remarkable that the violent fluctuations of DAX in October and November 2011 do not trigger a new regime, but are simply considered as oscillations associated with a negative regime exhibiting high volatility.

The return forecasts are then inserted in the machine learning classifier, i.e., an algorithm that identifies the relation among different forecasts that gives rise to later positive or negative returns. The bottom-right panel shows the link between predicted return values and investment signalisations. Yellow and blue areas correspond to investable and uninvestable regions, respectively. The classifier implements both procyclical and anticyclical decisions. For example, in overbought markets (when both long- and short-term forecasts are extremely positive) the classifier forbids investing. In oversold markets (whereby both long- and short- term forecasts are extremely negative), as well as during moderate market rallies (slightly positive, both long- and short-term forecasts), investments are allowed.

Modern Portfolio Theory:

Mathematical framework that constructs a portfolio such that the expected return is maximised for a given level of risk.

Investment Universe:

Set of assets in which a portfolio can be potentially invested.

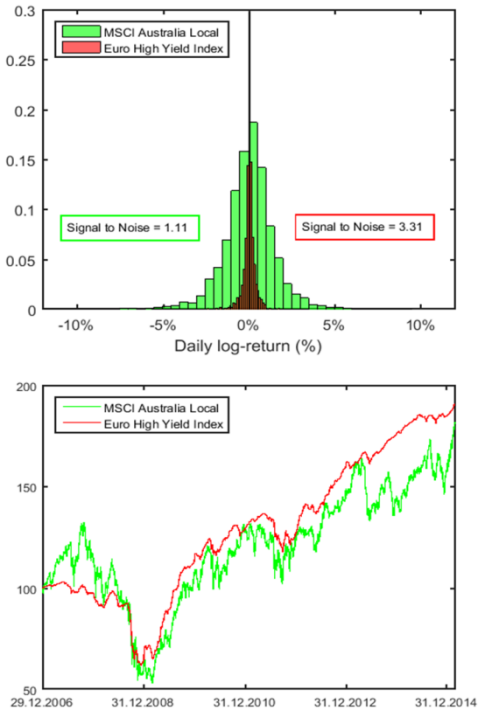

Figure 4: Signal-to-Noise ratio as predictability measure. The daily log-return distributions of Euro High Yield Index (red) and MSCI Australia Local (green) have a similar mean value however the uncertainty is larger in the Australian index and therefore the Signal-to-Noise ratio of the Euro High Yields Index is three times as high. Thus both indices are correlated - but the positive and negative regimes from Australia are much noisier. As a result the predictability of the Euro High Yield Index is significantly higher.

Constructing the basic components: highly diversified investment universes

Once a clear description of the raw materials is achieved, the Industry 4.0 era uses this information automatically to design the basic parts of the manufactured product. Under the Quant 4.0 scenario, this implies the design of the key components of the modern portfolio theory: return-risk estimations, and the investment universe.

With the risk and return estimators already introduced, the next step is the automatic construction of optimal investment universes. Previously, the definition of such universes was based upon intuition. Asset managers have tried to construct universes with high diversification and prediction potential, but they lack both tools to measure such quantities and a systematic approach to build universes upon them. To systematise the design of investment universes, GET Capital built "sensors" that are able to measure the predictability of a security's return and the diversification of a universe.

The predictability sensor is based on the "Signal-to-Noise" ratio - a measure used in physics and engineering that for a given security compares the level of the return forecast with the uncertainty in such a forecast (See Figure 4). From a financial perspective it determines how "clean" the positive and negative regimes are of a given security. The higher the "Signal-to-Noise" ratio, the easier it is to predict such a security. That is, the less volatile the regimes, the safer the forecast. The diversification sensor relies on Information Theory that is a branch of computer science involving the quantification of information. In plain words, the diversification sensor measures the amount of information shared among all the different securities that form an investment universe. That is, the insertion of highly correlated securities, e.g., DAX 30 and CAC 40, which share a big portion of information, does not add extra diversification. In contrast, the addition of lowly correlated securities, e.g., DAX 30 and MSCI Pakistan, with less shared information, is able to increase the diversification of the investment universe.

Once the predictability and diversification sensors are switched on, GET Capital uses these measurements to construct a highly predictable investment universe with optimal diversification (See "Diversification and predictability as a source of performance"). The strategy firstly uses novel big data analysis tools to cluster all potential elements of the universe in groups with homogeneous statistical behavior. Then, only the elements with the highest predictability are chosen from each cluster. This guarantees that the universe has predictable elements without losing diversification potential. Finally, to construct the final investment universe with the desired number of elements a complex optimisation algorithm is carried out, to determine the combination of securities with the highest diversification.

This Quant 4.0 systematic construction of highly predictable and diversified investment universes gives the portfolios access to outstanding risk/return ratios (See Figure 5).

Diversification and predictability as a source of performance

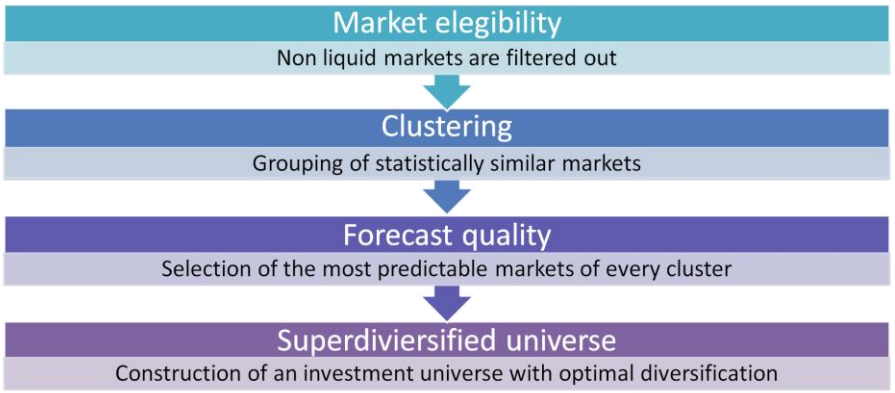

Figure 5: Workflow of the investment universe construction and GET Capital simulation performances

Large investment universes make detection of the global optimal allocation very difficult. Therefore, it is necessary to reduce the size of the universe whilst trying not to lose diversification potential. To do so, GET Capital combines market clustering, signal-to-noise ratios, and information content optimisations to construct small predictable investment universes with high diversification potential (See top panel).

The lower panel shows the result of combining the GET Capital approach and a highly diversified universe with bonds and equities. The corporate and government bonds are chosen from different countries, currencies, ratings, and maturities. Equities are selected from emerging and developed markets with low correlations between them. The diversification measure of this universe (1.07) contrasts with the diversification of a classical equity universe that takes values around 0.5.

The blue and green curves correspond to portfolios without constraints and customised with a limitation of 5% annualised maximum drawdown and risk budget of 10% expected shortfall, respectively. In both cases they implement the universe described above. These GET strategies achieve return/risk ratios superior to the main global aggregated indices – such as MSCI World (red curve). This investment profile is accomplished by profiting from attractive investment opportunities that the universe offers during different market scenarios.

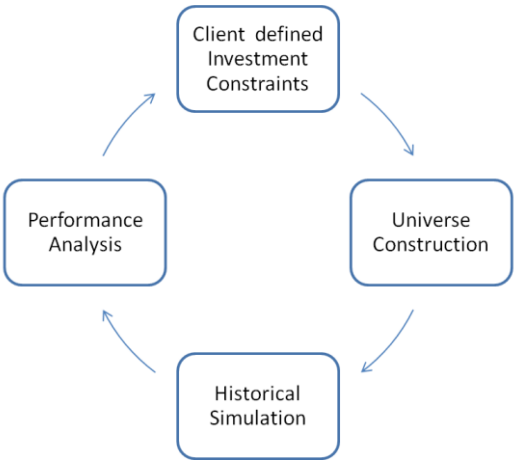

Figure 6: Quant 4.0 modelling cycle.

Customisation of the final product: tailor-made portfolios

Even after the design of the main components of the production process, the flexibility added by the Industry 4.0-era "smart" robots allows customisation of the final product according to client requirements. "Quant 4.0" must therefore offer the clients control over the portfolio by defining complex allocation constraints.

For an already designed investment universe and risk/return forecasts, GET Capital allows clients to include general purpose constraints in the optimisation algorithm that defines the portfolio's daily allocation. This permits effective portfolio management with CPPI constraints, drawdown limitations, risk budgets, regional and development maximal allocations, and asset class limits – to name but a few (See green portfolio in Figure 5).

Finally, Quant 4.0 uses portfolio simulations to test the real investment process. Every investment decision is firstly simulated and verified virtually; only once the final investment solution has been tested and approved, is the portfolio ready to operate in the real market (See Figure 6).

Portfolio Mass Customization:

Portfolio construction to meet individual customer's needs with near mass production efficiency

Portfolio Historical Simulation:

Computational imitation of the evolution of a given portfolio allocation over time.

Summary

In spite of the technological, scientific, and cultural challenges, the implementation of the Industry 4.0 productive revolution in the asset management industry is a "no-going-back" process. Interconnection of the capital markets, the huge amount of data, and the sheer speed of the markets make it impossible that human beings carrying out discretionary decisions can achieve optimal investment results.

GET Capital's Quant 4.0 solution is based on the combination of internet technology, big data analysis, and artificial intelligence algorithms that permits the automation, systematisation, and set-up of the whole production cycle. This includes online market tracking and prediction, rationalisation of both the investment universe design and the allocation proposal, and last - but not least - the virtualisation and testing of the whole investment process.

The modular and human independent Quant 4.0 execution of the investment cycle permits the scalability of the whole system without additional costs, and the successive and efficient further development of the investment approach. However, the main long-term advantage of the Quant 4.0 conversion is the transition towards a creativity- and knowledge-based corporative culture.

The complete portfolio customisation and the systematisation and forecasting capacities offered by the artificial intelligence algorithms are values added by the Quant 4.0 asset management system to client investments, which result in attractive risk/return ratios and the fulfillment of detailed tailor-defined requirements.

About GET Capital

Since its foundation in 2006 the leitmotiv of GET Capital has been the management of risk-adjusted institutional mandates through the combination of cutting-edge scientific methodology and deep financial understanding. Our revolutionary association of modern portfolio theory, big data, and artificial intelligence permits the construction of fully customised active portfolios that achieve long term risk/return ratios superior to the main global aggregated indices. The innovation is fundamental to the practical implementation of this guideline. Our staff comprises professionals with long experience in fundamental research, and qualified through doctoral degrees in physics, mathematics and computer science. The excellence-oriented philosophy of GET Capital and its interdisciplinary staff have been key aspects to successfully complete the new alliance between data, algorithms, and asset management.

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