Analysis on the Development of Quantitative Investment Model

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ABSTRACT
With the development of global securities market and the maturity of technology, quantitative investment has become one of the important tools for fund managers to make decisions. Therefore, what is quantitative investment? What role does quantitative investment play in the stock market? What are the types of portfolio investment and investment model? What are the differences? In the future development of world investment trend, what is the development prospect of quantitative investment model? Through the development of quantitative investment all over the world, as well as the development process and current situation of quantitative investment model, this paper analyzes and prospects the future development prospect of quantitative investment in the world.

Keywords: *quantitative investment, global securities market, stock market, portfolio investment, investment model, risk, alpha model, Risk control model, Transaction cost model*

1. INTRODUCTION

Quantitative investment is a common method of investment management. Quantitative investment management is based on the available public data, based on mathematical or statistical or physical methods, to establish a quantitative model to evaluate the stock and make investment decisions. Frontier investment model includes the cutting-edge models of various industries, including speech recognition, image recognition, artificial intelligence and other fields. The essence of quantitative management is statistical arbitrage, focusing on factors (commonness), rather than stocks (individuality). The basic assumptions include: (1) the market is mostly efficient; (2) pure arbitrage opportunities do not exist; (3) quantitative analysis creates statistical arbitrage opportunities; (4) quantitative analysis combines all possible information in an effective way; (5) quantitative model should be based on reasonable economic theory; (6) quantitative model should reflect a sustainable and stable model; (7) empirical research. The deviation between portfolio and benchmark is reasonable only when the uncertainty is small enough[1].

2. QUANTITATIVE INVESTMENT CONCEPT

In short, quantitative investment refers to the application of computer technology and mathematical modeling methods to achieve investment ideas and investment strategies. Quantitative investment originated from portfolio theory. With the development of investment management technology, computer technology and the gradual maturity of financial market, quantitative investment developed rapidly in the 1980s[2]. Quantitative investment is a kind of trading method based on data, model and procedural trading. It has the characteristics of huge trading volume, short position time and stable overall income[3].

2.1. Development stage of quantitative investment

The development of quantitative investment can be roughly divided into three stages. The first stage is the embryonic stage. The portfolio theory proposed by Dr. Markowitz in 1952 first quantified the risks and benefits, representing the embryonic stage of quantitative investment in the theoretical field. In 1971, the first quantitative fund was issued by the company, marking the beginning of the application of quantitative

investment in practice; the second stage is the slow development stage, from the 1980s to 1995, due to the limitations of technology and other aspects, quantitative investment did not make a breakthrough in foreign countries; the third stage is the rapid development stage, with the development of information technology With the support of technology, quantitative investment began to develop rapidly[4]. Up to now, the method of quantitative investment has been widely used, index investment and active investment basically use quantitative investment.

2.2. Development of quantitative investment model

Quantitative investment is the application of mathematical tools in the field of finance, which is the combination of Finance and mathematics.

2.2.1. Mean variance model

Markowiz published the article "portfolio selection", which proposed that the average rate of return of securities should be used to measure the return, and the standard deviation of the rate of return should be used to measure the risk. Finally, the conclusion is that the investment risk can be effectively reduced through the portfolio. The basic assumptions of Markowiz's portfolio theory are: (1) investors tend to avoid risks and maximize the expected return; (2) investors determine the portfolio according to the expectation and variance of the return rate; (3) investors are in the same single investment period. The expected rate of return e is used to measure the rate of return of securities, and the investment risk is expressed by the variance δ 2 of the rate of return. The total return of a portfolio is represented by the weighted average of the expected return of each asset, and the risk of the portfolio is represented by the variance or standard deviation of the return. Then Markowiz model is as follows: RP -- portfolio return; RI, RJ -- the expected return of I and j assets; wi, WJ -- the weight of I and j assets in the portfolio; RI, RJ -- the expected return of I and j assets; δ 2 (RP) -- the variance of portfolio return, that is, the overall risk of the portfolio; cov (R), the covariance between the two assets. According to Markowitz model, the reasonable goal of portfolio construction is to form an effective portfolio with the highest yield under a given risk level. In addition, Markowitz model provides an optimization process for constructing the most effective target portfolio, which has been widely used in portfolio management.

2.2.2. CAPM model

On the basis of Markowiz's mean variance model, Sharpe et al. simplified it to speed up the calculation by more than ten times. Under the less developed technical level at that time, it greatly improved the calculation efficiency and established the capital asset pricing model (CAPM) Type. CAPM model has been widely used in the field of financial management and investment decision. In the capital asset pricing model, beta coefficient is used to measure the relationship between portfolio return and market return, and portfolio return is related to market combination.

3. THREE FACTOR MODEL AND MULTI FACTOR MODEL

Fama, French (1992) made a more detailed decomposition of portfolio return, and established a more comprehensive linear model based on company size, excess return and book to market ratio. Because the investors who bear high risks must require high returns, the company size is negatively correlated with portfolio returns, and the book to market ratio is positively correlated with portfolio returns, which confirms the risk return theory. Three factor model is not only an extension of CAPM model, but also an application of APT model. Compared with the traditional subjective investment management, the multi factor model is more robust, and Renaissance technology, the most representative of which, has maintained an annual return of 29% in the past few decades. Commonly used factors include these categories: (1) valuation indicators. For example, PE, the stocks with lower PE are often thought to be undervalued in the same industry, and if there is no problem in the fundamentals, such stocks are likely to have excessive performance; (2) dividend indicators. It can be used to measure the company's operating status and more appropriately reflect the company's dividend capacity, such as ROA and roe; (3) emerging factors. Including emotional factors, such as indicators to measure the long short atmosphere of the market, indicators to measure trading sentiment, indicators to measure investor confidence and so on. At the same time, the factor model also has disadvantages. When the selected factor is included in the model, it will reduce the accuracy of the model. Therefore, we should carefully test every factor included in the regression equation. The essence of multi factor is to describe the characteristics of the stock. By observing the characteristics of the stock returns and corresponding factors in the past stages, we summarize the causality or correlation, and then establish the corresponding model. After years of development, multi factor model is no longer a simple statistical modeling, but an advanced modeling that integrates the cutting-edge and high-end forecasting methods of various disciplines. The level of modeling and the effectiveness of basic information determine the level of revenue competition.

3.1. Quantitative Financial Model and Risk

Alpha model originates from the basic theory of quantitative investment, that is, the portfolio return

proposed by William sharp in 1963 can be regarded as a combination of beta return and alpha return. The beta return comes from the systematic risk of the market, and the alpha return is the overdue return beyond the systematic risk return of the market. It can be seen that the so-called alpha model is a model in the quantitative trading model that is responsible for analyzing and predicting the market data and obtaining excess returns through strategies such as trend following and high-frequency trading. The model is the core of the whole quantitative investment system, and the accuracy and timeliness of market forecast is the key to the effective implementation of the strategy. In the alpha model system, there are mainly two types: theoretical model and data-driven model. The theoretical model designs and estimates various parameters of the market and establishes mathematical models based on economic principles. Its typical models include trend following model, mean reversion model and value investment model, It can be said that the theoretical alpha model is the representative of mathematical modeling and computer simulation of fundamental investment method and technology investment method in investment science. The data-driven model is more complex. To some extent, it abandons its dependence on traditional economic principles and uses data acquisition and mining technologies such as crawler technology represented by Python language to process and analyze real-time massive information. It often tends to use higher-order algorithm patterns and data processing methods to simulate and evaluate market logic and the future, From this perspective, it is more like a school of technology investment in the field of quantitative investment. It pays more attention to the significance represented by real-time data than theory.

3.2. Difference between risk control model and alpha model

The risk control model is different from the alpha model. Compared with the alpha model with the fundamental purpose of obtaining return, the purpose of the risk control model is to control risk. For the quantitative investment fund, the alpha model will simultaneously trade a variety of objects in multiple investment markets and build multiple portfolios. For the system constructed by either a single portfolio or multiple portfolios, a control model is needed to distribute and control the system trading risk, which is not just a stop loss in the traditional sense. More importantly, the risk control model has the obligation to ensure the return quality generated by the alpha model and the continuity and stability of operation. Through the principle of equal risk sharing, establish the average risk mean among the new alpha models constantly constructed, stabilize the investment return by allocating the proportion of high-risk portfolio and low-risk portfolio, reduce the investment risk, and control the risk exposure, and carry out selection and scale control. Like alpha model, risk control model can also be divided into theoretical driven model and empirical model. The theory driven risk control model uses the system risk theory in economic theory to analyze the risk factors and establish a model to achieve the purpose of risk control, while the empirical risk control model is based on historical data to discover and estimate the risks of different markets and objects through data mining.

3.3. Transaction cost model

Transaction cost model is a different model type. There are three different types of transaction costs, as follows.

Transaction Costs		
The Search	**The Bargaining**	**The Enforcement**
The costs to research to identify an item to purchase	The costs associated with negotiating a deal	Costs to verify the terms of the agreement have been met
Examples	**Examples**	**Examples**
The time and expense of gathering information	Time spent at meetings to reach a deal	Legal fees to close a transaction
Identify the item to be purchased	The time spent haggling over a price	Confirming the items identified in due diligence have been completed
Identify a funding source	The cost to complete due diligence	Time and money spent monitoring an aggreement after it closes
Identify potential buyers or sellers		

Figure 1. Three types of transaction costs

Its purpose is neither to reduce risk nor to increase income, but to support the stable operation of the first two models. Obviously, whether it is alpha model or risk control model, if you want to build a model to fit the market ahead or reduce the risk ahead stop loss, you need frequent transactions to build or hedge the portfolio, resulting in massive transaction costs. It is estimated that more than 20% of the transaction income will be eroded. At the same time, because quantitative transactions often master large amounts of funds, a large order will cause irrational fluctuations in the market, seriously affect the pre transaction prediction of alpha model and risk control model, and make the model invalid or fail in the transaction. Therefore, the importance of transaction cost model is that its successful implementation can ensure the effective operation of the first two model systems. At present, transaction cost models are mainly divided into constant model, linear model and quadratic model. The constant transaction cost model is based on the assumption that the transaction cost is the same and does not consider the transaction scale, while the linear model will consider the linear relationship between transaction cost and transaction scale. The final quadratic model is conducive to the quadratic function to fit the relationship between transaction cost and scale more closely, but its algorithm and complexity are also the highest level[6].

4. CONCLUSION

In the developed financial market, quantitative trading accounts for 70% of the total trading volume, accounting for a very large proportion. Through the use of various quantitative investment models, quantitative investment will face certain upgrading and transformation. In the future development process, it will also play a more important role in the financial market.

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