Class of 2025 – 4th year of engineering course
Financial Engineering major & HPC-AI track

Zhongtai Securities Research Institute
Team Financial Engineering
Shanghai, China

Leonard De Vinci Engineering School
Paris, France

Tutor of school: Vincent LAMBERT
Tutor of enterprise: Xiaowei NI

Asset Allocation Analyst

Hugo Xinghe CHEN

April – July 2024

Oral defense: July 5th 2024

Non-confidential document

Introduction

During the summer of 2024, I had the privilege of completing a **3-month international internship** as an **asset allocation analyst** at the **Research Institute of Zhongtai Securities**, a leading financial services firm in **Shanghai, China**. Zhongtai Securities specializes in a wide range of securities and investment-related activities, including brokerage, investment consulting, underwriting, proprietary trading, and asset management.

I worked within the **financial engineering team**. As an intern, my primary mission was to **establish an investment clock model** to better visualize macroeconomic cycles.

This involved researching economic indicators, analyzing historical asset performance, and determining optimal weightings across **stock, bonds, commodities and gold**, etc. Through this precious hands-on experience, I gained various skills in data analysis, investment modeling, and cross-functional collaboration.

This report will provide an overview of the investment clock model I developed, the key insights obtained, and the competencies I cultivated as an asset allocation analyst intern at Zhongtai Securities. The experience has been invaluable in strengthening my passion for the investment management field and better preparing me for a future career as a professional in the field of finance.

Acknowledgements

I would like to express my sincere gratitude to **Zhongtai Securities Research Institute Shanghai office** for providing me with the opportunity to complete this internship.

I am particularly thankful to my supervisor/ **tutor of enterprise, M. Xiaowei NI**, the Head of the financial engineering team, for her mentorship and guidance throughout the internship.

I would also like to extend my appreciation to other **colleagues at the Research Institute**, who provided valuable support.

Finally, I am grateful to my **tutor of school, M. Vincent LAMBERT**, and other **professors at my engineering school** for their encouragement and for equipping me with precious knowledge and the necessary academic foundation to succeed in this internship.

Table of Contents

Professional context of the internship

Introduction to the market

The seven largest **securities markets** in the world include the US, China, Japan, France, the UK, Canada, and South Korea. Of these, the **Chinese market** stands at **2nd position in the world** regarding total size after the United States. It has a total volume of nearly **$100 trillion** which is roughly **12% of the worldwide** total volume.

The securities market is a financial market where one can buy and sell securities against demand and supply. The security market involves **stock markets, bond markets, and derivatives markets** wherein the prices are known and the participants may be professionals or non-professionals and meet.

The securities market functions on two major levels: **the primary market**, for issuing fresh securities, and **the secondary market**, for trading existing securities. Moreover, the secondary market can also be further differentiated between structured exchanges, including stock markets, and **over-the-counter markets**, involving individual entities buying and selling securities directly with each other. It provides security holders with the assurance that they have an avenue to sell securities for cash should they so wish, which boosts investors' confidence in maintaining stocks and bonds, and, at the same time, increases the ability of firms to issue new securities.
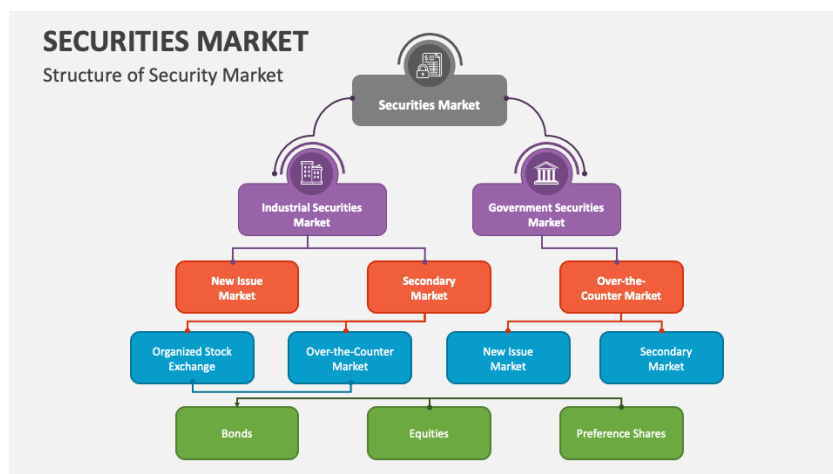
Structure of securities market

During my internship, I had the opportunity to practice one of the most important activities in any investment strategy: **asset allocation**. It refers to that section of her investments that involves juggling the mix of different assets in one portfolio to **strike a delicate balance**—that which is tailor-made for the investor's tolerance of risk, financial objectives, and investment horizon. This strategy looks at **optimizing the total characteristics of the portfolio** and not having a sole focus on individualistic myopia.

Indeed, financial literature and experts have always articulated the opinion that the **greatest determinant** of the returns attained by an investment portfolio is asset allocation. The very crux of asset allocation is that the strategies have been founded on the primary idea that **different assets perform differently under different market and economic conditions**. In simple terms, it is based on the argument that different asset classes will yield returns that are less than perfectly correlated to lower the overall risk by reducing the volatility of the returns for any given expected rate of return. The very term—one only finds a free lunch—associated with asset diversification in investment describes a general rule or the prime importance of the same.

However, although academic research confirms this principle of asset allocation, it also draws attention to some **weaknesses of active management strategies**. In ordinary cases, however, such risk prediction, although it is diminished through diversification, primarily lies on statistical relationships from a set of historical data, including correlations and variances. The inherent reliance of traditional asset allocation methods on historical data allows investors to project future returns and risks with the assumption that past trends **may not continue indefinitely**. This is a **forecasting method**, fundamentally grounded in mean-variance optimization from modern portfolio theory, which often creates precisely such lopsided asset allocations that are quite removed from investment objectives and practical portfolio management strategies.

It is a unit of study related to a vast literature of academic research for the betterment of methodologies in forecasting, with all efforts broadly directed at **improving this strategy of portfolio management** in itself. There is a **great need** for both investors and finance professionals to grasp such **critical nuances** of asset allocation for constructing a resilient, goal-driven investment portfolio in the event of an **ever-changing** market environment.

Assets chosen for the allocation model

Presentation of the company

Zhongtai Securities Co., Ltd. was established in **2001**. It is a large comprehensive publicly listed securities firm in China. The company has **44 branch offices** and over **280 securities business departments** in 28 provinces and autonomous regions nationwide. With a workforce of over **9,000 employees**, the company creates a diversified business development pattern in securities, futures, funds, and investments.

Zhongtai Securities serves over **8.5 million wealth management clients**, managing client assets exceeding **1.2 trillion RMB** (about 168 billion USD). It ranks **9th nationwide** in terms of

the number of equity underwritings and IPO underwriting scale among more than 140 securities firms.

Zhongtai Securities provides diversified backdrop services in finances within all domains and markets of China for:

- **Securities Brokerage**: Intermediation in the purchase and sales of securities.
- **Underwriting and Sponsorship**: Helps the issuers in registering and lending of new securities, so that they open.
- **Investment Consulting**: Consulting and seeking professional guidance regarding investment opportunities.
- **Securities Trading**: Diversified selling and dealing in securities on the stock exchange.
- **Financial Advisory**: Consultation for matters about money.
- **Margin Trading**: Executing the orders for borrowing to invest in the securities on the client's behalf.
- **Fund and Financial Product Distribution**: Day in and day out, the mutual funds and the other financial products issued to the investors are actively sold by this group.
- **Fund Custody**: The investment funds are securely held for clients.
- **Stock Options Market-Making**: The quoting of the bid and ask prices so that liquidity is offered on the stock options market.

Zhongtai Securities aimed to adhere to the two bottom lines of **compliance in business operations and honest practice**, hone the three capabilities of promoting high-quality development, serving customers, and preventing and resolving risks, and achieve four breakthroughs: **increasing the quantity and quality of the customer base, comprehensive coordination of business systems, intelligent empowerment in financial technology, and effectively enhancing capital strength.** It will work to bolster the five large business sectors: wealth management, investment banking, investment trading, research and institutions, and asset management. It shall center around strengthening the core functions of major strategy implementation, serving the real economy, fostering common prosperity, and maintaining financial stability. It will secure **core competitiveness in business, management, brand, talent, and technology.** It will drive improvement in the comprehensively enhanced quality and efficiency of all work and continuously extend its scale and strength. It will constantly create new advantages for the company's high-quality development, bearing the banner of Shandong's securities industry, striving to build a first-class securities company that is loyal, compliant, innovative, and shared by all.

Zhongtai Securities Research Institute is one of the most influential securities research organizations in China. It provides professional direction for investments with in-depth analysis. It was founded in **2003**, headquartered in Beijing, and is the core research center for Zhongtai Securities. In 2024, the Research Institute is composed of about **230 analysts**. During the past 5 years, according to my tutor, there have been about 150 analysts who left the institute

because of the competitiveness of this job in China and lack of need during the COVID-19 pandemic.

My work location: Shanghai office is located at the center of **Shanghai's CBD**.
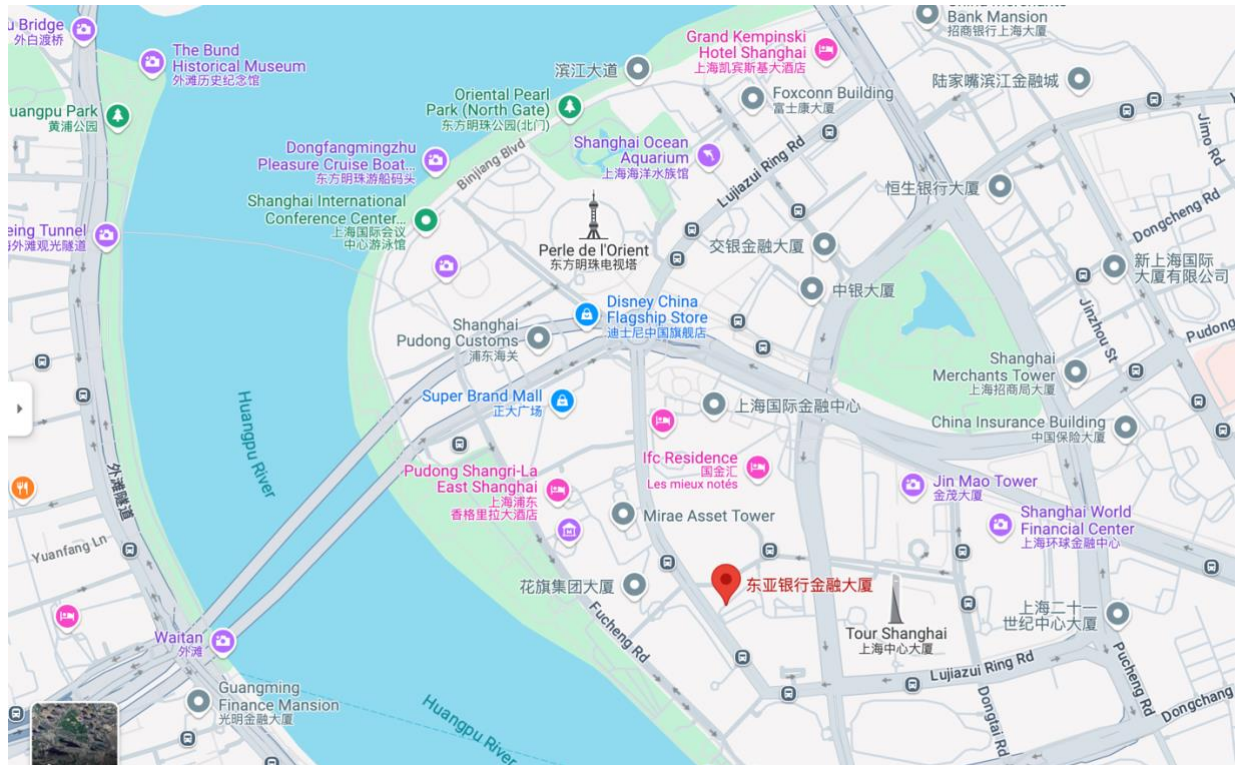
Location of Shanghai office

Research Institute provides investors with **systematic research and reports** in cooperation with the invested consultation services in this field, covering the **economy, finance, and the capital market**. The institute goes deep into these sectors and, consequently, empowers investors to implement informed investment strategies.

It is an important, far-reaching platform. Their thematic research includes macro, industry, company, and others. Macroeconomic researchers pinpoint how relevant indicators and needed policies—income growth, inflation, monetary policies—affect the capital market. This is characterized by **the in-depth study of the market trends and competitive dynamics** of a certain industry. Firm research primarily looks at how healthy the finances are, how profitable, and the valuation metrics of the listed firms.

With the application of a vast number of research methodologies, the institute adopts the following basic analysis, technical analysis event studies. Fundamental analysis consists of studies made in preparation to **establish the value and profitability of a company created by a detailed analysis of its financial data.** Technical analysis is the interpretation of market trends and conditions through price action and trading volume analysis. Event studies can be

found that measure the effect some events have on the market landscape—like a policy change or even a corporate merger.

Positioning of my post

In April 2024, I joined the **financial engineering team as an intern analyst. My enterprise tutor, M. NI**, is also the **manager of the team**. The financial engineering team has in-depth research and practice in the field, especially in **risk management, quantitative analysis, investment strategies**, etc.

The financial engineering team not only conducts in-depth research on the operating **mechanism of the financial market in theory**, but also meets the **risk-return preference needs** of different customers through practical applications, such as all-weather multi-strategy research products. These products are based on the **risk parity method**, synthesizing four types of sub-strategies such as stocks, bonds, futures and options to achieve the goal of crossing the bull and bear markets, and provide **systematic and flexible investment strategies**. In addition, the team also uses chaos engineering to **improve the fault tolerance of the system**. By actively injecting disturbances that may cause failures into the system, exploring the system's tolerance for disturbances, testing the system's behavior under various pressures, identifying and repairing fault problems, and avoiding serious consequences.

The financial engineering team not only demonstrates its innovative ability in the field of financial technology, but also demonstrates its efforts to improve the quality and efficiency of financial services. By combining theoretical research and practical applications, Zhongtai Securities provides investors with more diversified and personalized investment options.

Internship presentation

Objectives

As an asset allocation analyst in financial engineering, my **principal objective** was to **allocate 4 major assets (stock, bonds, commodities, and gold)**. More precisely, I had to **establish an investment clock model** to do the allocation using previous research and papers. Then I needed to **backtest it to evaluate its performance.** At the end of the internship, I was asked to do **floating frequency fitting** to predict trends using another economic cycle forecast.

Internship Roadmap

Planning

1. **Orientation Phase**

- Understand the role and responsibilities of an asset allocation analyst in the financial engineering team.

- Familiarize the company's mission, values, and existing asset allocation strategies.

- Set learning goals for the internship period.

2. **Research and Preparation**

- Study the basics of asset allocation, financial engineering, and risk management.

- Identify key industry trends, tools, and methodologies used in asset allocation.

- Review the company's current asset allocation strategies and performance metrics.

3. **Establishment of the investment clock model**

- Construction and selection of indices

- Macro–asset mapping

- Factor's period prediction

- Backtests of the model

Needs Analysis

1. **Data Treatment**

- Gather historical financial data, market trends, and economic indicators.

- Data cleaning

- Conduct risk assessment and evaluate the performance of existing portfolios.

2. **Learning existing investment clock models**

- Choice of macro-factors

- Precise macro-asset relation mapping

- Finding a better way to detect patterns

Methods and Tools Used

1. **Methods**

- Arrival at least 30 minutes before the start of my workday.

- Taking notes at any time when discussing with my tutor or other colleagues.

- Making weekly and monthly planning to better structure my missions and time

2. **Programming language**

- Python

Python is a versatile, high-level programming language known for its simplicity, readability, and extensive applications across web development, data science, AI, and automation. With a large standard library and active community support, Python is a popular choice for developers worldwide. Because of its convenience, the financial engineering team uses it for programming models.

3. **Applications**

- Visual Studio Code
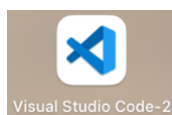
Visual Studio Code is a versatile, user-friendly code editor with cross-platform compatibility, extensive language support, a rich extensions marketplace, an integrated terminal, and seamless version control integration. It allows our financial engineering team to better collaborate and collect data from any kind of API.

- Wind (widely used in China as Bloomberg)

Wind is in a leading position in China's financial information service industry, providing important services to many securities companies, fund management companies, insurance companies, banks, investment companies and other financial institutions.

Wind's services cover stocks, bonds, funds, foreign exchange, financial derivatives, commodities, macroeconomics, financial news, and other fields.

Wind provides a series of professional analysis software and application tools in the fields of information retrieval, data extraction and analysis, portfolio management applications, etc. Specific services include Excel plug-in, **Client API**, Wind 3C Conference, and Mobile terminals.

Teams Involved

The team collaborates with all analysts of the institute during our daily morning online meeting. Due to the independence of analysts' jobs, we don't work directly with other teams. Most analysts watch trends in the market, and we will provide needed information using financial engineering specialties such as quantitative analysis, etc.

Regulatory Aspects

1. **Compliance**

- Adhere to regulatory requirements related to asset allocation, risk management, and client suitability.

- Stay updated on industry regulations and guidelines governing financial products and services.

Quality / Risk Management

1. **Risk Assessment**

- Conduct regular risk assessments to identify and mitigate potential risks in asset allocation strategies.

2. **Quality Control**

- Establish quality control measures to monitor the performance of asset allocation models and portfolios.

- Conduct periodic reviews and evaluations to assess the effectiveness of asset allocation strategies.

- Optimization of models.

Internship progress

Presentation of missions

- Study the basics of Financial Economics

- Construction of investment clock model

- Optimization of model

- Establishment of floating frequency fitting for prediction

## Description of missions

Enrichment of my knowledge

I learned the basics of financial economics, focusing on its vital concept. I devoted time to studying Candlestick charts, as known as K-Line charts, and studied some well-known patterns that helped me analyze current market trends. Attending Daily Morning Meetings provides information on the current and near-future market status. It also involved the discussion of academic papers and reports, enhancement of my analytical skills, and further development of knowledge in financial markets. I was able to learn the basics of asset pricing, which allowed me to evaluate different investment opportunities and risks subsequently. Communication with team managers and analysts lets me work easily with them and share knowledge.

Study of investment clock

The Investment Clock is a Marco investment strategy first introduced by Merrill Lynch. It is a simple but useful framework for understanding the different phases of a business cycle and finding the best performing asset classes in each phase. The Investment Clock divides the business cycle into four phases. Each phase includes the direction of growth and inflation relative to their trends.

- Cyclicality: When economic growth accelerates, stocks and commodities perform well. Cyclical sectors, such as high-tech or steel stocks, outperform the market. When economic growth slows (south), bonds, cash, and defensive portfolios outperform the market.

- Duration: When inflation rates fall, discount rates fall, and financial assets perform well. Investors buy growth stocks with long cycles. When inflation rates rise, real assets, such as commodities and cash, perform well. Value stocks with low valuation fluctuations and short cycles outperform the market.

- Interest rate sensitivity: Banks and discretionary consumer stocks are interest rate sensitive and react the earliest in a cycle. They perform best in recessions and recoveries when central banks ease monetary policy and growth begins to recover.

- Correlation with the underlying asset: The performance of some industries is linked to the price movement of the underlying asset. Insurance stocks and investment bank stocks tend to be sensitive to bond or equity prices and perform well in recessions or recoveries. Mining stocks are sensitive to metal prices and perform well in overheating phases. Oil and gas stocks are sensitive to oil prices and outperform in stagflation phases.
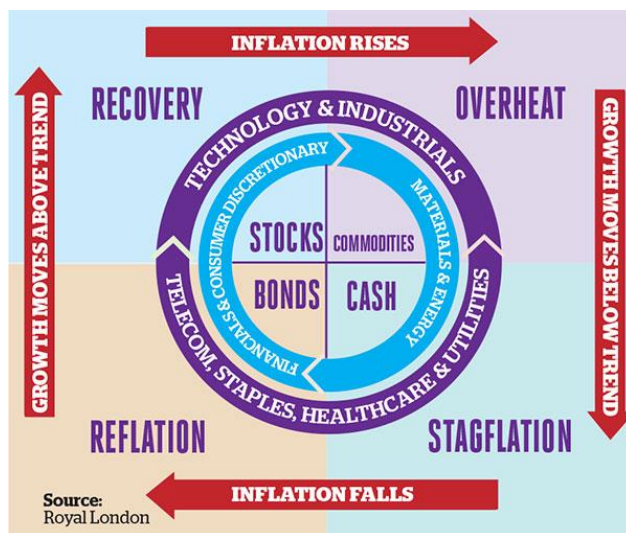
Example of Merrill Lynch Investment Clock

Data treatment

Considering that the statistical caliber and data frequency of different macro indicators are inconsistent, and there are varying degrees of data missing and seasonal interference, it is necessary to conduct unified preprocessing of macro indicators. The purpose is to make the caliber of each indicator comparable and facilitate the identification of each Lead-lag relationship between indicators.

Although the details of processing different indicators vary, in general, it can be summarized as the following five steps:

1. **Download data:**

By using the integrated application WindPy of Wind API, I was able to download wanted data directly from the API and get accurate and up-to-date data. So here I just download total volume indicators or price indicators without seasonal adjustment. All data of this model is ranged **between January 31st 2008 and June 30th 2024.** And also this model uses **monthly data** due to the publication frequency of most of indices.

2. **Unify caliber:** Unify all indicators into the monthly frequency year-on-year growth rate caliber

Since the statistical caliber, data frequency, degree of data missingness, and seasonal significance of different indicators are different, there are also some differences in the implementation details of the unified caliber. Due to space limitations, this article takes several typical indicators as examples to briefly introduce the steps to unify the caliber:

1) Monthly value data: represented by production indicators such as power generation, extract the end-of-month value and then interpolate.

2) Cumulative value data of the current month: Taking the completed amount of real estate development investment as a representative, it is converted into value data of the current month through the month-on-month difference, in which the cumulative value in February is equally divided into January and February.

3) Price data: Taking pork price as a representative, extract the monthly average.

4) Chain data: represented by CPI and PPI, converted into total caliber through cumulative multiplication.

5) Diffusion index: Taking PMI as the representative, first subtract 50 and divide by 100, convert to the ring-to-ring caliber, and then use the ring-to-ring caliber. The data is processed in the same way.

Eventually, indicators of different calibers and frequencies will be unified into monthly year-on-year growth rate data.

3. **Seasonality test:** Test whether there is significant stable seasonality and moving seasonality in macro indicators, and combine it with subjective logic.

When I introduced the preprocessing of the CPI indicator earlier, I mentioned that preprocessing should be done using total volume caliber or price caliber data.

It is not a direct download of year-on-year data. This is because the Spring Festival, which has the most significant holiday effect, is unevenly distributed in the Gregorian calendar months. The process of calculating year-on-year growth cannot completely offset the seasonal factors in different years, and the unoffset part is usually no longer significant and cannot be easily adjusted seasonally. The algorithm identifies and separates, resulting in biased year-on-year growth.

To clarify the above discussion, I introduce the stationary seasonality test method and the moving seasonality test method. Stable seasonality means that there is a significant difference between the multi-year averages of macro indicators in month t1 and month t2; moving seasonality means that the difference between macro indicators in month t1 and month t2 changes significantly between different years. If an indicator has both significant moving seasonality and stable seasonality, then total volume or price data should be used for seasonal adjustment.

4. **Seasonal adjustment:** After eliminating the holiday effect of the Chinese New Year, X-11 is used to extract trend items and cycle items.

Macro indicators often contain trend term (T), cycle term (C), seasonal term (S), and irregular term (I), which are decomposed using the multiplication model as follows: $Y = T \times C \times S \times I$

Among them, the trend term measures the long-term trend of the indicator, the cycle term reflects the fluctuation term that deviates from the long-term trend, the seasonal term is caused by the mid-year cyclic changes caused by factors such as the distribution of holidays in different months of the year, the number of working days and seasonal climate changes, and the irregular term reflects the impact of emergencies and noise on macro indicators.

5. **HP filtering (Hodrick–Prescott filter):** Further eliminate trend items and focus on the periodic fluctuations of cyclic items.

After seasonal adjustment, the seasonal term (S) and irregular term (I) of the macroeconomic indicators are stripped off, leaving the trend term (T) and the cyclical term (C). In an incremental economy, the trend term (T) tends to be steadily upward. In order to study the fluctuation law of the economic cycle, the cyclical term (C) is usually further extracted for targeted analysis, and the most common method to remove the trend term is HP filtering. Let Xt be the trend-cyclical term sequence adjusted seasonally: $Xt = Tt \times Ct$

HP filter is to separate Tt from Xt, and the following objective function needs to be minimized:

$$z = \sum_{t=1}^{N} (X_t - T_t)^2 + \lambda \sum_{t=2}^{N-1} [(T_{t+1} - T_t) - (T_t - T_{t-1})]^2$$

The first term of the objective function means that the trend term is as close to the original sequence as possible, and the second term means that the trend term is as smooth as possible. The two are mutually restrained: when λ=0, the trend term is the original sequence without any smoothing; as λ increases, more and more high-frequency information in the original sequence is separated, and the trend term becomes smoother and smoother. The selection of λ requires a trade-off between the degree of trend tracking and the degree of trend smoothness. In general, for annual data, λ is 100; for quarterly data, λ is 1600; **for monthly data, λ is 14400.**

6. **Year-on-year transformation:** Finally, the cyclic item is transformed into a year-on-year growth rate, which is a common practice in studying incremental economies.
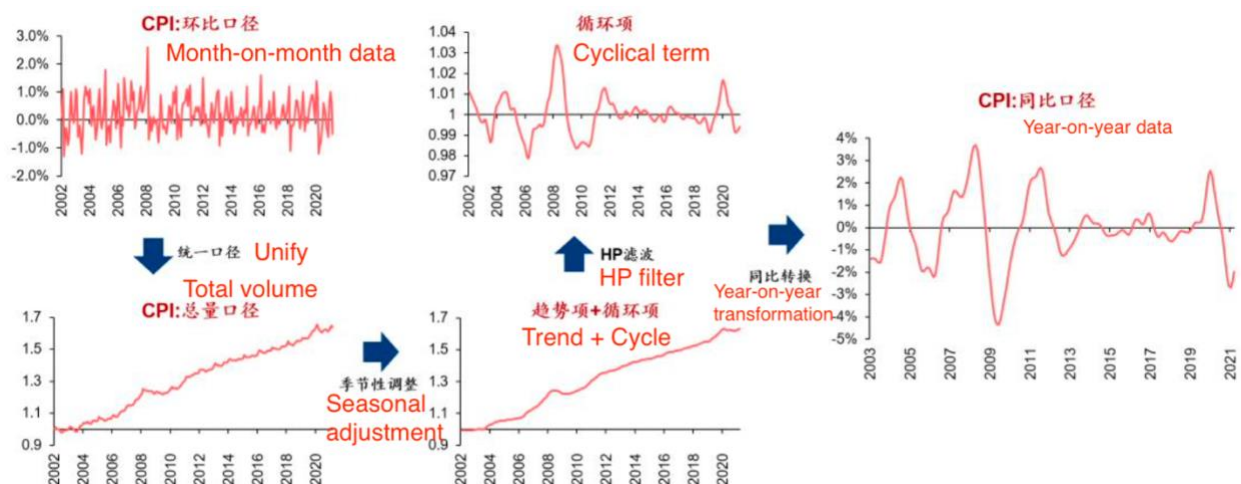
Process of data treatment

Selection of 4 macro factors

As Merrill Lynch Investment Clock only covers 2 macro factors: Increase and Inflation, its performance has already been proven to be bad. So, after lectures on many papers, I decided to establish an investment clock with 4 factors: **Increase, Inflation, Credit, and Currency.** It allows me to measure the "quantity" and "price" of the real economy's prosperity, as well as the "quantity" and "price" of the liquidity environment.

Construction and selection of a pool of corresponding benchmark indices and leading indices

The construction of the indicator pool mainly relies on subjective logic, and selects macro indicators that are directly related to macro variables in each dimension in turn. Take growth as an example: in addition to directly referring to aggregate indicators such as GDP and PMI, we can also select subdivided indicators through accounting methods such as production method (industrial added value, output of various industrial products), expenditure method (investment, consumption, import and export troika), and income method (corporate profits, public fiscal revenue). Similarly, for dimensions such as inflation, credit, and currency, we also selected corresponding proxy indicators.

In general, as long as the indicators have clear economic meanings, sufficient statistics, and timely release, we have included them in the indicator pool. The final constructed indicator pool is shown in the figure, which contains more than 500 macro indicators.

Here, I set **PMI, CPI & PPI, M1-PPI, and one-year treasury bond yield** as Increase, Inflation, Credit, and Currency's benchmark indices.

After establishing the benchmark indicators, we will first evaluate the leading and lagging relationship between each indicator in the candidate indicator library and the benchmark indicators from a quantitative perspective. The methods used include time-difference correlation

coefficient, K-L information volume, inflection point matching rate and curve shape matching degree. Only when all four tests are passed can the requirements of leading indicators be considered to be met. For indicators that pass the quantitative initial screening, we will further consider factors such as data length, logical connection, statistical adequacy, and indicator attention to determine the final leading indicators.

Macro factors	Benchmark indices	Leading indices
Increase	PMI	Electricity Generation, Aluminum, Sulfuric Acid, Air Conditioners, Automobiles, Forklifts, Total Freight Turnover, Tax Revenue, Real Estate Development Investment Completed Amount
Inflation	CPI & PPI	Pork, Rebar, CRB Oil and Fat Index, Crude Oil, Cement
Credit	M1 - PPI	M2, Total Social Financing, Financial Institution Loan Balance
Currency	One-year Treasury bond yield	R007, SHIBOR: 3 Months, USD/CNY

Selected indices for 4 factors

Construction of macro-factor indices

Commonly used macro-factor synthesis methods include diffusion index method, composite index method and principal component analysis method. However, since the OECD method has the longest history and is the most widely used, this paper finally uses the OECD method to construct the macro-factor system.

The **OECD method** refers to the method used by the Organization for Economic Cooperation and Development (OECD) to compile macroeconomic indicators of member countries.

The calculation steps are as follows:

1) Let the candidate index be C and calculate its standardized deviation SDj:

$$SD_j = \left(\sum_t \left| C_j(t) - \bar{C}_j \right| \right)/T$$

2) Calculate the standardized sequence SCj of each indicator:

$$SC_j = \left(C_j(t) - \bar{C}_j \right)/SD_j$$

3) Summing SCj gives S:

$$S = \sum_j SC_j$$

4) Adjust the magnitude of S according to the order of magnitude of the benchmark indicator X to obtain the final composite index CI:

$$k = \left(\sum_t |X(t) - \bar{X}|\right)\Big/\left(\sum_t |S(t) - \bar{S}|\right)$$

$$d = \bar{X} - \bar{S}$$

$$CI = k \times S + d$$

The purpose of amplitude adjustment is to make the composite index consistent with the benchmark index in magnitude and easy to compare. The OECD method is easy to calculate and **does not involve any information loss**. For indicators with large fluctuations, the standardized deviation is large, so the OECD method will give them a lower weight to reduce the interference of noise on the composite index. However, when there are alternative indicators with highly overlapping economic meanings in the indicator pool, **the OECD method will repeatedly calculate their weights, so when screening indicators, try to avoid indicators with too high correlation.**
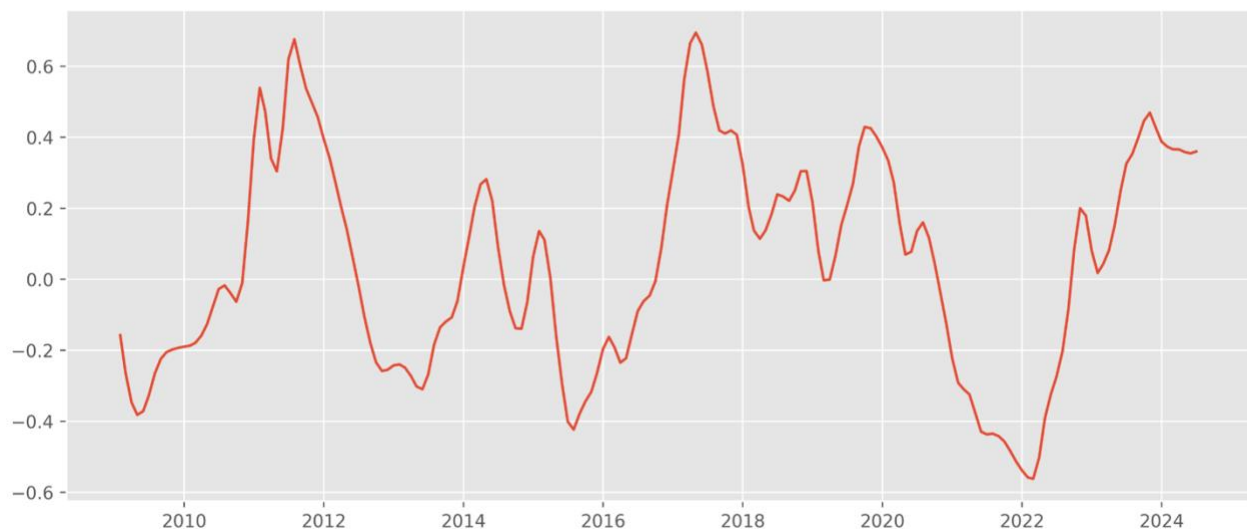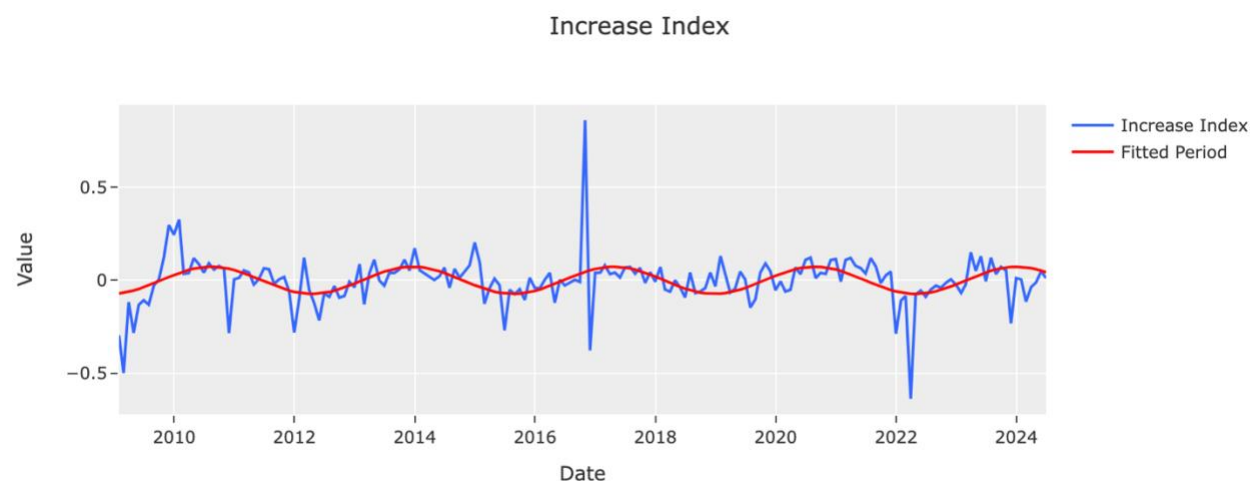

Example of Currency factor using the OECD method

Macro-environmental economic period fitting

By comparing different lengths of periods, I can finally choose the best period to fit our factors.
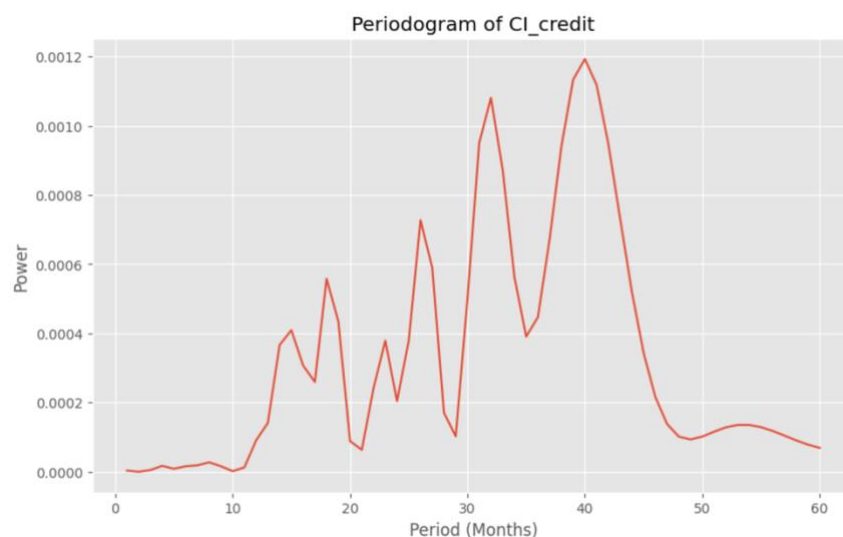
Example of the period choosing result of Credit factor

Increase factor after period fitting

Macro–asset mapping

Taking CSI 800, China Bond-Treasury Bond Total Net Price Index, Nanhua Industrial Products Index, and gold to represent stocks, bonds, commodities, and cash-like assets respectively, the performance of assets in the upward and downward segments of each factor is as follows:

Growth factor: An upward trend is positive for stocks (corporate profits pick up) and commodities (resource demand increases), but negative for bonds (increased financing demand drives interest rates upward). In addition, compared with the growth benchmark factors, the income

differentiation of stocks, bonds, and industrial products among the growth leading factors has significantly expanded, highlighting the advantages of the leading factors.

Inflation factor: Rising inflation is good for industrial products (supply and demand imbalance, price expansion) and gold (increased demand for value preservation). The impact of inflation on stocks is mainly reflected in the structural differentiation of sectors; on bonds, it is a correlation rather than a causal relationship. Similarly, compared with inflation benchmark factors, leading factors also show certain advantages in asset return differentiation.

3) Credit factor: It mainly distinguishes stocks significantly. When credit expands, stocks go up, and when credit shrinks, stocks go down.

4) Monetary factor: It mainly distinguishes bonds significantly. When the currency is loose, the bonds will rise, and when the currency tightens, the bonds will fall.

Factor's signal		Stock	Bonds	Commodities	Gold
Increase	⬆	Long	Short	Long	Hold
	⬇	Small short	Long	Small short	Small long
Inflation	⬆	Hold	Small short	Long	Long
	⬇	Hold	Hold	Short	Short
Credit	⬆	Long	Hold	Small long	Small long
	⬇	Small short	Hold	Small short	Small short
Currency	⬆	Hold	Small long	Short	Hold
	⬇	Hold	Small short	Long	Hold

Macro–asset mapping relation

Factor's period prediction

Thanks to the period fitting part, I have already got the needed function to complete my period prediction part. Inside the backtesting part, I used the 60 previous months so 5 previous years to forecast the next macro environments.

Combined Indices with Future Predictions
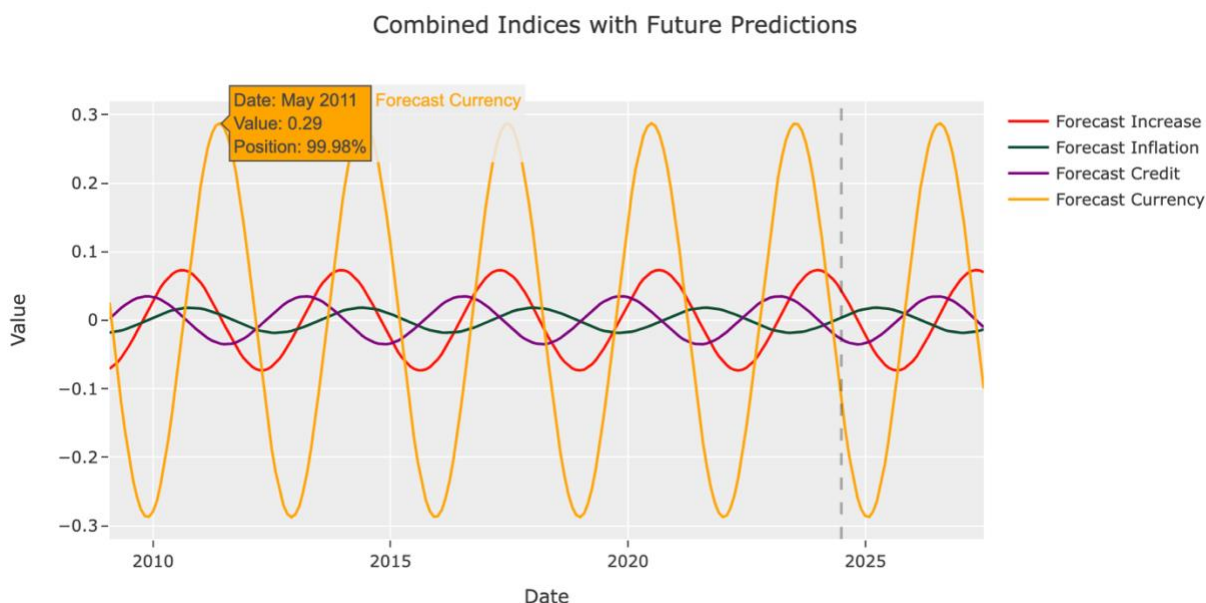
Example of factors' period prediction

Investment strategy

The process of constructing the macro factor investment clock strategy is as follows:

1) At the strategic level, a benchmark portfolio is constructed based on a fixed weight ratio or risk budget ratio. In the empirical study below, a fixed risk ratio is used as the benchmark portfolio in the major asset scenario, and an equal-weight portfolio is used as the benchmark portfolio in the industry allocation scenario.

2) Based on all the historical information of the macro indicators available at the cross-section, the indicators are pre-processed and the historical macro factor sequence up to the cross-section is synthesized using the OECD method. The reason why all historical information is used here, rather than just the information in the rolling window, is to avoid excessive interference from the short-term fluctuations of the indicators on the synthetic weights; in order to ensure that there is enough data for factor sequence synthesis, January 31st, 2014 is taken as the first cross-section.

3) Based on the macro factor sequence synthesized at the cross-section, the phase judgment method and the factor momentum method are combined to generate macro factor views. This is the core link in strategy construction. The principles of the two methods will be introduced in detail later.

4) According to the macro view and the macro-asset mapping relationship, the portfolio weight or risk budget ratio is tactically adjusted to obtain an actively managed portfolio.

In addition, I used the **period position decision method**. Considering that the rolling forecast uses an ideal sine wave (strictly symmetrical) obtained by the signal processing algorithm, in

fact, the up and down intervals of each cycle are not necessarily equal in length, which will lead to deviations in the inflection point identification. In this regard, this paper divides $\pi/2\pm\pi/6$ into the top interval, $3\pi/2\pm\pi/6$ into the bottom interval, and the others as trend segments:

1) When the phase is in the up/down trend segment, the corresponding factor up (1) and down (-1) views are directly given.

2) When the phase is in the top interval, if the factor is positive year-on-year, the factor up view (1) is maintained, otherwise no view (0) is given. 3) When the phase is in the bottom interval, if the factor is negative year-on-year, the factor down view (-1) is maintained, otherwise no view (0) is given.

Also, I added the **factor momentum method**. Factor momentum is defined as the difference between the current factor value and the average of the past three periods. A value greater than zero indicates a bullish outlook, while a value less than zero indicates a bearish outlook.

In order to avoid too frequent signal triggering, the following quantitative rules are followed when publishing opinions:

1) When the factor momentum is positive for two consecutive periods, the opinion of factor upward (1) is given;

2) When the factor momentum is negative for two consecutive periods, the opinion of factor downward (-1) is given;

3) In other cases (the positive and negative factors of the factor momentum are inconsistent for two consecutive periods), no opinion is given (0).

In the end, I combine the period position decision method and the factor momentum method with the proportion of the golden number (0.382 : 0.618).

In order to evaluate the effect of macro factors on the asset allocation strategy as fairly as possible, it is necessary to introduce some factors into the benchmark portfolio that may have direct or indirect links with macro factors and can also improve the strategy, such as valuation.

For valuation, we introduce the equity risk premium (ERP) indicator. The ERP indicator is equal to the inverse of the arithmetic average rolling price-to-earnings ratio (val_pe_avg) of the CSI 800 Index minus the 10-year Treasury bond yield.
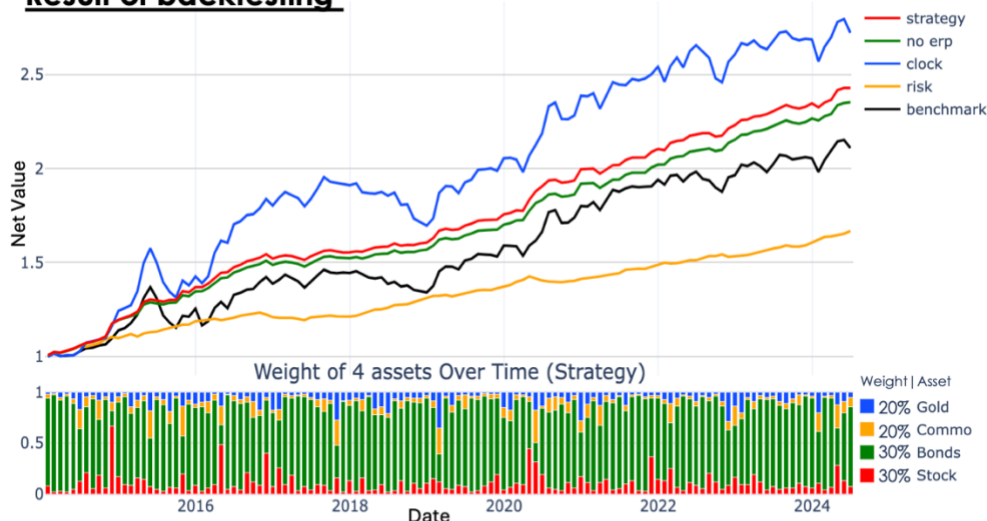
At the end of the month, we calculate the quantiles of the ERP indicator in the past 860 trading days (approximately equal to 1 Kitchin cycle). When the quantile of the ERP indicator is greater than 82%, stocks are seriously undervalued relative to bonds, and stocks are more cost-effective. We increase the risk budget ratio of stocks and reduce the risk budget ratio of bonds; when the quantile of the ERP indicator is less than 18%, stocks are seriously overvalued relative to bonds, and bonds are more cost-effective. We reduce the risk budget ratio of stocks and increase the risk budget ratio of bonds.

I did several comparisons between different methods and it proved that a good combination of these methods helps to improve the performance of the model.

Backtesting and optimization of model

Result of my investment clock model

Here are the strategies being compared: "Strategy", "No ERP", "Clock only", "Risk only", and "Benchmark".

'Benchmark' is the one when we don't do anything with our assets, so it will remain **the weight of 0.3 : 0.3 : 0.2 : 0.2 for stock, bonds, commodities, and gold.** Even though it seems to be unlogic, it still leads the annual return to 7.37% and unfortunately 0.53 for the Sharpe ratio.

'Risk only' means we only consider the volatility to adapt weights. The reason that I didn't use other risk measures is because of team choice, as my tutor asked to adapt with their familiar utilization. So we can see it's the most stable one and with an annual return of 4.99% which is not bad in reality.

'Clock only' is the strategy that combines the period position decision method and the factor momentum method with the proportion of the golden number (0.382 : 0.618). This totally shows the power and importance of our investment clock model because it only relies on our Macro

factor's period fitting and prediction. With an annual return of 10.00%, we can say it performs well. But it still lacks lots of stability due to its volatility and its huge max drawdown.

'No ERP' was the general investment clock strategy. In addition to the 'Risk only' consideration, it applies to 'Clock only' as well. With an annual return of 8.49% and a 1.59 Sharpe ratio, we can already say that it's a good strategy.

'Strategy' is the final strategy with all introduced methods previously. Thanks to the weight changes due to ERP performance, we achieved a Sharpe ratio of 1.60 and the lowest max drawdown with an annual return of 8.82%.

Then, the reason we choose gold as the 4th asset is due to its performance in recent years.

	Net value	Annualized return %	Volatility %	Max Drawdown%	Sharpe Ratio
Stock	1.791392	5.709345	23.232108	−48.443917	0.116621
Bond	1.675890	5.040483	1.987820	−3.229952	1.026493
Commodities	2.191476	7.758397	15.537340	−28.971761	0.306256
Gold	2.325467	8.369167	12.190697	−17.455182	0.440432

Performance of 4 assets since 2008

Establishment of floating frequency fitting

Floating frequency fitting refers to the methodology followed in analyzing the frequency content in a signal or dataset. It typically consists of adjusting model parameters, and using statistical or computational tools for the best fit. First, the selection must be made about which model or algorithm would best represent the frequency characteristics of data. Then, the parameters of such a model are adjusted to best match the frequency variation observed. This may include fitting and refining data so that the model fits the frequency structure in the data. Performing floating frequency fitting will enable the identification of periodic patterns, trends, or other frequency characteristics in the data that could be of real value for further analysis and interpretation of the data.

In floating frequency fitting, the Fourier function can be used to represent the frequency components in the data. Through Fourier transform, we can convert a time domain signal into a frequency domain representation to reveal the components of different frequencies in the signal. When performing floating frequency fitting, Fourier analysis can be used to identify the main frequency components in the data, and then the parameters of the fitting model can be adjusted based on these frequency components to better fit the frequency characteristics in the data.
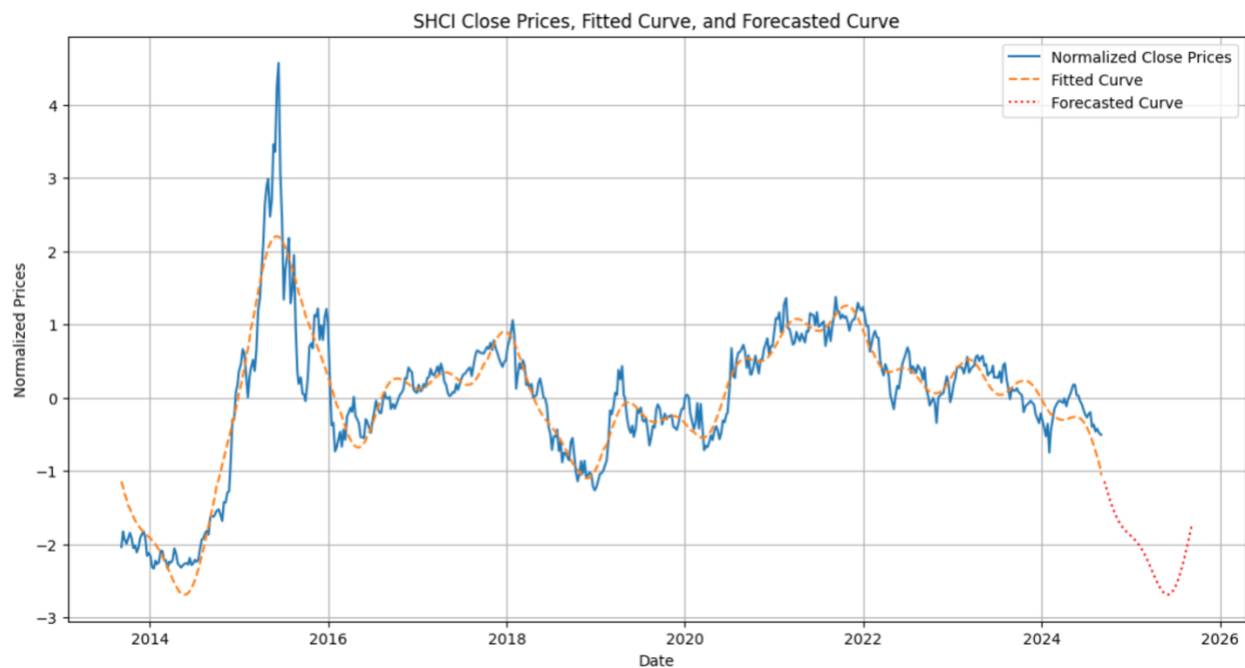
Example of floating frequency fitting & prediction with top10 frequencies

Conclusion

My internship at Zhongtai Securities Research Institute has been a transformative experience, providing me with invaluable insights into the world of asset allocation analysis and financial engineering. Over the course of three months, I had the opportunity to delve deep into the intricacies of developing an investment clock model to visualize macroeconomic cycles, a project that not only honed my technical skills but also fostered cross-functional collaboration and strategic thinking.

Through meticulous research, data analysis, and backtesting, I was able to gain a profound understanding of asset allocation strategies involving stocks, bonds, commodities, and gold. This hands-on experience not only enhanced my proficiency in investment modeling but also equipped me with essential skills in risk management and performance evaluation.

The internship roadmap I followed, from the orientation phase to the establishment of the investment clock model, provided a structured approach to achieving my objectives. By utilizing tools like Python for programming and applications like Visual Studio Code and Wind for data analysis and collaboration, I was able to streamline my workflow and enhance the efficiency of our financial engineering team's operations.

Collaborating with fellow analysts during daily meetings and adhering to regulatory compliance and quality control measures underscored the importance of teamwork, diligence, and precision in the field of asset allocation analysis. The experience has not only deepened my passion for finance but has also prepared me for a future career in investment management.

I am immensely grateful to Zhongtai Securities Research Institute, my supervisor M. Xiaowei NI, my tutor of school M. Vincent LAMBERT, and my academic mentors for their guidance and support throughout this enriching internship journey. The competencies I have cultivated and the experiences I have gained will undoubtedly serve as a solid foundation for my professional growth and success in the dynamic world of finance.

The results obtained demonstrate that my efforts have been fruitful, and the challenges I faced have pushed me to excel. I particularly valued the work environment and collective willingness to go above and beyond. This internship not only allowed me to acquire new skills but also strengthened my ability to adapt and tackle complex challenges.

Source

https://www.investopedia.com/terms/a/assetallocation.asp

https://medium.com/@richardhwlin/how-does-investment-clock-work-c7d8fbbeb7bd

https://xueqiu.com/7951322469/280520736

Zhongtai Securities. "Multi-dimensional risk-balanced quantitative asset allocation model - Machine Learning Series 2"

Zhongtai Securities. "Investment Clock: Spring, Summer, Autumn and Winter"

Huatai Securities. "Industry Allocation Strategy-Investment Clock Perspective"

Annexes