

A Study of Risk Differences in Internet Money Funds Based on The Prophet Model

Yue Wu *

School Of International Business, Tianjin Foreign Studies University, Tianjin, China, 300270

* Corresponding Author Email: yueyueko711@163.com

Abstract. With the development of Internet finance, Internet money funds have gradually become an important choice for investors due to their convenience, high liquidity and low risk. This study analyzes the return volatility and trend of bank-based, fund-based and Internet enterprise-docked financial products using Prophet model. The results show that the return volatility of bank-based and fund-based financial products is small, and the model prediction accuracy is high; the return volatility of Internet enterprise docking type financial products is large, and the prediction difficulty is high but the overall trend prediction is better. The study also finds that bank-based and fund-based financial products fluctuate significantly in terms of holiday and weekly trends, while Internet business-docking financial products have less impact. Overall, the Prophet model can better predict the overall trend of financial products and provide reference for investors.

Keywords: Prophet Model, Internet Money Funds, Return Volatility.

1. Introduction

As a new financial business model of capital financing, payment, investment and information intermediary services, Internet finance occupies an irreplaceable position in expanding the financing and wealth management channels of "long-tail groups" and accelerating the formation of a new financial ecosystem in China^[1]. With its rapid development, Internet finance has become a significant financial business model. Consequently, Internet money funds have gradually become an important choice for investors. Internet funds include Internet money funds, Internet stock funds, Internet bond funds, Internet mixed funds and other different types. These funds not only provide a convenient investment channel, but are also favored for their higher liquidity and lower risk. The emergence of Internet money funds has changed the pattern of the traditional financial market and provided a new way of financial management for the majority of investors, becoming an important force in the financial market.

The convenience of Internet money funds is mainly reflected in their low threshold and high liquidity. Investors can easily purchase and redeem funds through Internet platforms without complicated procedures and high initial investment. This convenience attracts a large number of small and medium-sized investors, especially the younger generation, who prefer to carry out financial operations through mobile devices. In addition, Internet money funds usually offer higher yields, which are more attractive compared to traditional bank deposits. This makes Internet money funds the first choice of many investors. However, Internet money funds still face problems such as adverse selection, information distortion and maturity mismatch, which bring corresponding risks^[2].

Since the emergence of Internet money funds, there have been significant ups and downs in the level of their returns. Taking Balance Treasure as an example, it was opened to the public in June 2013, and roughly half a year later, its annualized return reached the highest level of 6.6%. Until now, its yield has not been able to break through this level again. After that, its yield has been declining. In September 2018, it dropped below 3%; in April 2020, it dropped below 2%, and on November 18, 2022, it dropped to 1.292%, which is its all-time low, so it can be seen that the ups and downs and fall of the yield are relatively large^[3].

In this context, this paper uses the seven-day annualized return data of 15 Internet money funds for a total sample of 2,000 days from February 26, 2019 to August 17, 2024, and conducts an in-depth

analysis of their return volatility and trends using the Prophet model, with a view to exploring the factors affecting the returns of Internet money funds.

The innovations of this paper lie in the following aspects: (1) Refinement of Research Scope: This study extends prior research by applying the Prophet model to a broader classification of Internet money funds, categorizing them into Internet enterprise-docked, bank-based, and fund-based products, rather than the traditional scale-based approach. This classification better captures the diverse operational strategies and market positioning of different fund types. (2) Enhanced Research Design: Utilizing five years of high-frequency data, this study provides a more comprehensive and long-term perspective on return trends and volatility, which is longer than the typical data period used in similar studies. The integration of multiple data sources ensures that the analysis closely reflects the operational environment of Internet money funds, making the findings more representative and actionable. (3) Model Innovation and Performance: Compared to traditional models like VAR and GARCH, the Prophet model demonstrates superior performance in handling complex seasonality, outliers, and exogenous shocks. By incorporating holidays and special events as predictors, the model aligns with the financial calendar, improving its accuracy in predicting both short-term and long-term trends. This methodological innovation enhances the model's applicability for risk management and investment decision-making.

2. Literature review

In 2013, Alipay took the lead in making innovative moves, it directly cooperated with the fund company docking, and the products sold on the platform - Balance Money Fund, with its flexible redemption, as well as high returns and low-risk features quickly set off a boom, officially opened our country's Internet "treasure" products "The first year of Internet wealth management in China has officially begun"^[4]. The first year of China's Internet wealth management has officially begun.

However, as the scale of Internet money funds continues to expand, their potential risks have gradually attracted the attention of academics and regulators. In order to better understand and manage these risks, scholars have conducted in-depth analyses of their yields and risks using various methods. Li Zhipeng (2015) used the GARCH model and the VaR (Value at Risk) measure to compare three types of funds: traditional funds, Internet-docked traditional funds, and pure Internet funds, and argued that pure Internet money funds should be regarded as low-risk and robust financial products^[5]. Based on the GARCH-CoVaR model, Chen Ke (2017) studied the risk spillover effect of Internet money market funds and financial markets, and found that the risk of Internet money funds is generally controllable, and there is a negative spillover effect of money fund products on financial markets^[6]. The risk of Internet money fund is generally controlled, and there is negative spillover effect of money fund products on financial market. Haiyan Wang (2021) constructs a TVP-VAR model based on the variables of the return on balance, money supply, interbank lending rate, fund size growth rate, and return on similar products, and finds that the positive shocks of economic policy uncertainty and money supply have a negative impact on the return on balance^[7]. Tian Ranran (2023) used fuzzy hierarchical analysis to evaluate the risk of Internet money funds on a macro level, and then measured the return risk of Internet money fund products on a micro level based on the GARCH model, and concluded that among the risks of Internet money fund products, the highest one is credit risk, followed by competition risk^[8].

Although a large number of studies have analyzed Internet money funds using VAR, GARCH, and other models, the unique advantages of the Prophet model in time series forecasting make it an attractive alternative. Compared to traditional VAR and GARCH models, the Prophet model has several advantages: the Prophet model captures seasonal variations well, and performs particularly well in the presence of multiple seasonal cycles (e.g., annual and weekly). Prophet is robust to outliers, missing data, and can make reasonable predictions on cluttered data^[9].

Traditional models may require a more sophisticated structure when dealing with complex seasonal components; Prophet models can easily introduce holidays and special events as predictors,

which is of great importance in financial markets because these factors may significantly affect the fund's return and risk. Given these advantages, this paper uses the Prophet model to predict and analyze the risk of Internet money funds. This paper uses high-frequency data for up to five years to ensure the reliability and representativeness of the analysis. By introducing holidays and special events, the model is closer to the actual market situation, which improves the accuracy and practicality of the prediction. It is expected to provide a more accurate and comprehensive risk assessment and a new perspective and methodology for the sound development of Internet money funds.

3. Model and data

3.1. Modeling

Prophet is a data prediction tool based on Python and R languages open-sourced by Facebook. The algorithm is designed based on time series decomposition and machine learning fitting, and can handle not only the presence of outliers in the time series, but also some of the missing values, to fully automate the prediction of the future trend of the time series^[10]. The algorithm is designed to predict the future trend of the time series in a fully automated manner. The algorithm uses the pyStan open-source tool in fitting the model to get the desired prediction in a faster time. prophet is an additive model consisting of a trend term, a period term, a holiday term, and an error term^[11], as shown in equation (1).

$$p(t) = g(t) + s(t) + h(t) + \varepsilon_t \quad (1)$$

where $g(t)$ is the trend term, indicating the trend of the time series above the non-periodic; $s(t)$ is the period term, which can also be called the seasonal term^[12] which, by default, is measured in weeks live years; $h(t)$ is the holiday term, which indicates whether there is a holiday on that day or not; ε_t is the error term^[13].

The holidays added to the model are shown in Table 1.

Table 1 Summary of holiday

festive days	dates
New Year's Day	Jan 1, 2020; Jan 1, 2021; Jan 1, 2022; Jan 1, 2023; Jan 1, 2024
Chinese New Year	Jan 25, 2020; Feb 12, 2021; Feb 1, 2022; Jan 22, 2023; Feb 10, 2024
Qingming or Pure Brightness Festival or Tomb Sweeping Day (in early April)	2019.4.5, 2020.4.4, 2021.4.4, 2022.4.5, 2023.4.5, 2024.4.4
International Labor Day (May Day)	Apr 5, 2019; Apr 4, 2020; Apr 4, 2021; Apr 5, 2022; Apr 5, 2023; Apr 4, 2024
the Dragon Boat Festival (5th day of the 5th lunar month)	Jun 7, 2019; Jun 25, 2020; Jun 14, 2021; Jun 3, 2022; Jun 22, 2023; Jun 10, 2024
the Mid-Autumn Festival on 15th of 8th lunar month	Sep 13, 2019; Oct 1, 2020; Sep 21, 2021; Sep 10, 2022; Sep 29, 2023
PRC National Day (October 1st)	Oct 1, 2019; Oct 1, 2020; Oct 1, 2021; Oct 1, 2022; Oct 1, 2023

3.2. Overview of data

In view of the research objectives of this paper, this paper divides Internet money funds into three categories, i.e., Internet business-to-business financial products, bank-based financial products, and fund-based financial products^[14]. Five representative funds in each category are selected for analysis, as shown in the table 2 below.

Table 2 Basic information on selected funds

Affiliated categories	Fund Name	Fund Code	Fund size (in 100 million RMB) (as of June 30, 2024)
Internet business-to-business financial products	Bosera Hopewell Currency B	004137	1525.62
	GF Daily Red Currency A	000389	1346.25
	ETF Cash Money	000330	725.25
	Harvest Call Money Currency A	000464	118.25
	South Cash Plus Currency A	202301	50.72
Bank-based financial products	Guangfa Currency A	270004	39.91
	Harvest Currency A	070008	74.56
	Xinhua YINBAO Currency A	000434	37.42
	Efatar Daily Wealth Management Currency A	000009	88.34
	Yinhua Currency A	180008	662.42
Fund-based financial products	ICBC Salary Currency A	000528	76.32
	Huaxia Cash Plus Currency AE	003003	461.22
	Bank of Communications Currency A	519588	3.26
	China Merchants Invitation Wallet Currency A	000588	1287.51
	BOC Callable Treasure Currency A	000539	1188.63

On the basis of selecting the above three major types of Internet money funds as the research sample, this paper chooses only the seven-day annualized returns of the funds as the time series. In order to ensure the accuracy of the empirical analysis results, the data are selected to expand the time span as much as possible to ensure the adequacy of the sample. The data timeframe of this study is from February 26, 2019 to August 17, 2024, which contains a total of 15 funds with a 2000-day sample, and the data source is eastmoney.com.

In order to better understand the data collected, some basic statistical characteristics of the 15 Internet money funds were calculated, and the results are shown in Table 3.

Table 3 Descriptive statistics

Affiliated categories	Fund Name	Mean value (%)	Standard deviation (%)	Maximum value (%)	Minimum (%)
Internet business-to-business financial products	Bosera Hopewell Currency B	2.46	0.354487	3.4470	1.8230
	GF Daily Red Currency A	2.07	0.336979	3.0160	1.3930
	ETF Cash Money	2.06	0.387524	3.6800	1.1820
	Harvest Call Money Currency A	2.09	0.329514	2.9550	1.4070
	South Cash Plus Currency A	2.01	0.31235	3.0960	1.3740
Bank-based financial products	Guangfa Currency A	2.08	0.321139	3.2380	1.2630
	Harvest Currency A	2.02	0.358928	3.1650	1.0980
	Xinhua YINBAO Currency A	1.85	0.441188	4.4910	0.9350
	Efatar Daily Wealth Management Currency A	2.04	0.347816	2.8810	1.3860
	Yinhua Currency A	1.95	0.330769	2.7670	1.2590
Fund-based financial products	ICBC Salary Currency A	2.11	0.408281	4.0660	1.4210
	Huaxia Cash Plus Currency AE	1.98	0.459863	4.8640	1.0490
	Bank of Communications Currency A	1.90	0.266111	2.9810	1.0920
	China Merchants Invitation Wallet Currency A	2.01	0.333228	2.8880	1.2500
	BOC Callable Treasure Currency A	2.15	0.365454	3.0630	1.5800

As shown in Table 3, Bosera Hopewell Currency B has the highest average 7-day annualized return, while Bank of Communications Currency A has the lowest 7-day annualized return. The higher average yield of Internet business-to-business wealth management products, along with their smaller standard deviation, may be attributed to their higher capital liquidity and more flexible investment strategies. In contrast, the performance of fund-based wealth management products varied more, which could be attributed to the significant differences in the investment strategies of different funds.

3.3. Data standardization

In order to eliminate the effect of different scales on the data analysis, the data were standardized by Z-Score in this paper. The formula is as follows:

$$z = \frac{x - \mu}{\sigma} \quad (2)$$

where x is the original data, and μ is the mean of the data set, and σ is the standard deviation of the data set.

4. Analysis of empirical results

4.1. Model component analysis of Internet business-to-business financial product groups

The figure 1 reveals that its overall trend shows a downward trend on a two-year cycle; in terms of the holiday factor, the impact is more even and basically positive. This may be due to the fact that users are more inclined to invest their idle funds in financial products during the vacation period in order to obtain short-term returns. At the same time, Internet companies may launch various promotional activities during the holiday period to attract users to invest, thus boosting return performance during the holiday period. As for the weekly trend, the impact of the Internet companies' docking-type financial products group is smaller, probably because users are used to investing regularly on a monthly or quarterly basis rather than operating frequently on a weekly basis, which also leads to a smaller impact on the weekly trend.

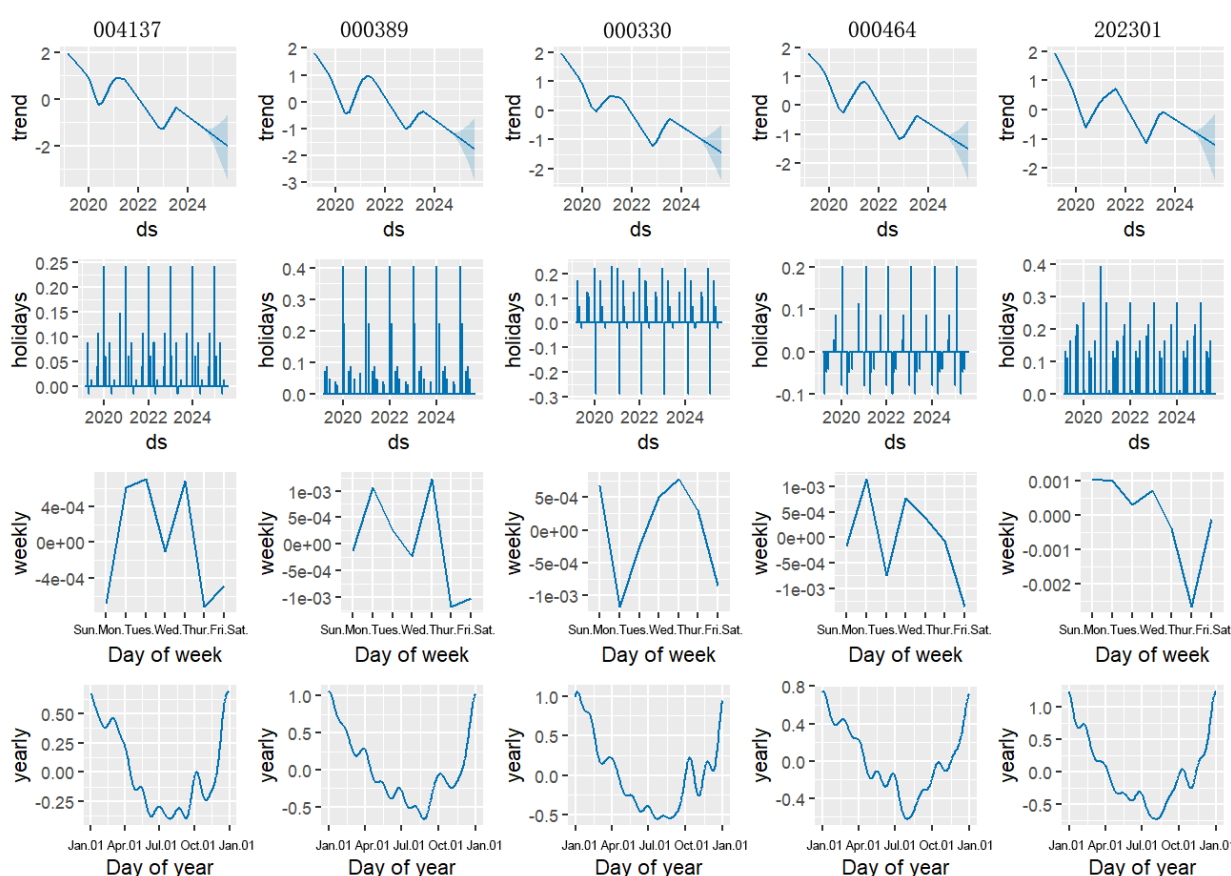


Figure 1 Decomposition of Prophet Model Predictions for Internet Business-to-Business Financial Product Groups

4.2. Model component analysis of bank-based wealth management product groups

The figure 2 shows that the holiday factor impact of the bank-based financial product group exhibits upward and downward fluctuations, and its absolute value varies widely and significantly, especially for Xinhua OneNobao Currency A, whose holiday factor impact is all negative. With respect to the weekly trend, the impact of the banking-based financial product group is larger relative to the Internet group, probably due to the fact that banks need to manage their liquidity to ensure that they have sufficient cash flow at different points in time during the week to meet their clients' withdrawal needs and other payment obligations. The high level of trading activities by banks during the week, especially the allocation of funds at the beginning of the week and settlement operations at the end of the week, can have an impact on the returns of financial products. The large upward and downward fluctuations exhibited in terms of the annual trend may be due to the banks' monthly

adjustments to the asset allocation of their financial products based on market conditions and risk assessment, as well as the reallocation of assets at the end or beginning of the month in order to satisfy liquidity needs, which may lead to fluctuations in yields. The beginning and end of the month are usually a period of financial settlement and capital reallocation for corporations and individuals, and these capital flows can affect the performance of financial products.

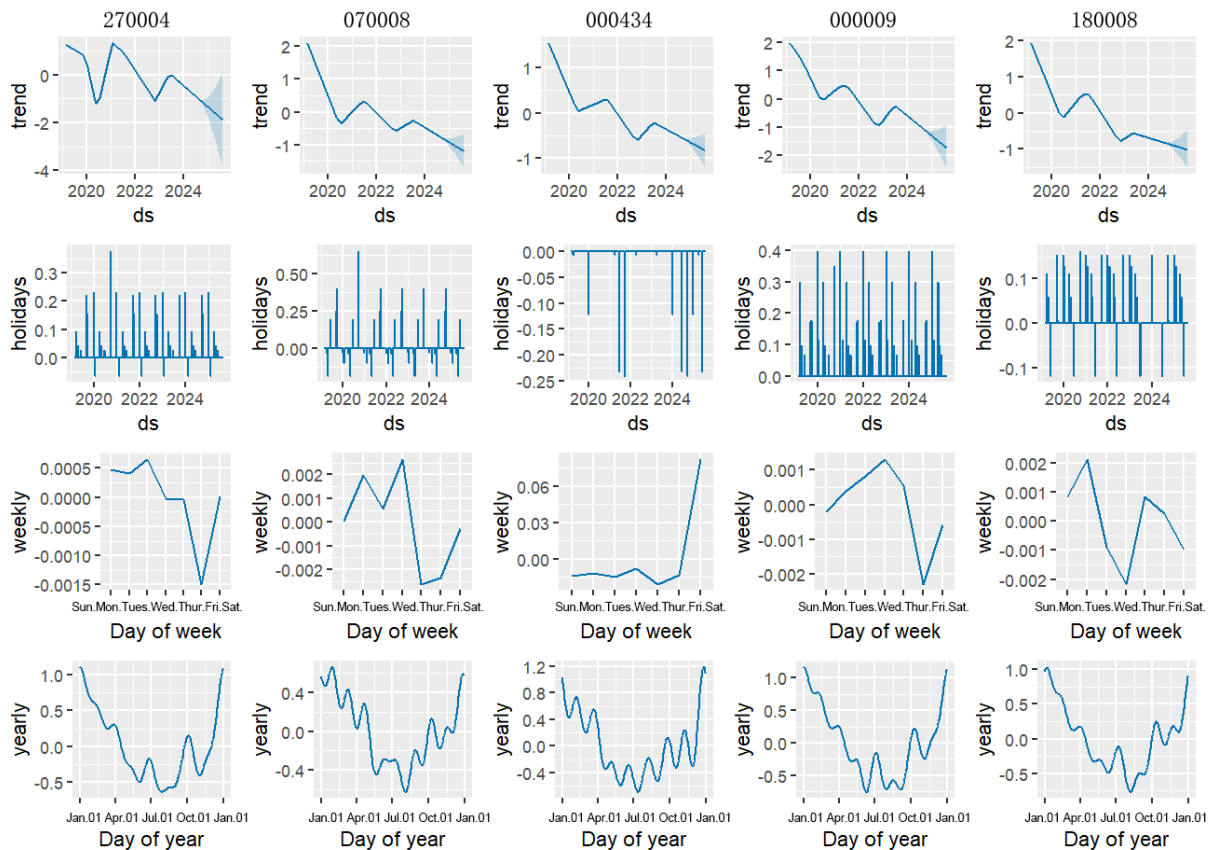


Figure 2 Decomposition of Prophet Model Predictions for Banking System Financial Product Groups

4.3. Model component analysis of fund-based financial product groups

As depicted in Figure 3, fund-based financial products exhibit significant volatility during holidays, influenced by their investment strategies and asset allocations. Some funds fluctuate more due to short-term trading, while others remain stable with long-term strategies. Annually, Internet business-to-business, bank-based, and fund-based financial products show convergence trends, driven by macroeconomic factors, market volatility, and investor behaviors. Market adjustments, asset reallocations, and policy regulations collectively impact these trends, causing different financial products to exhibit similar annual changes.

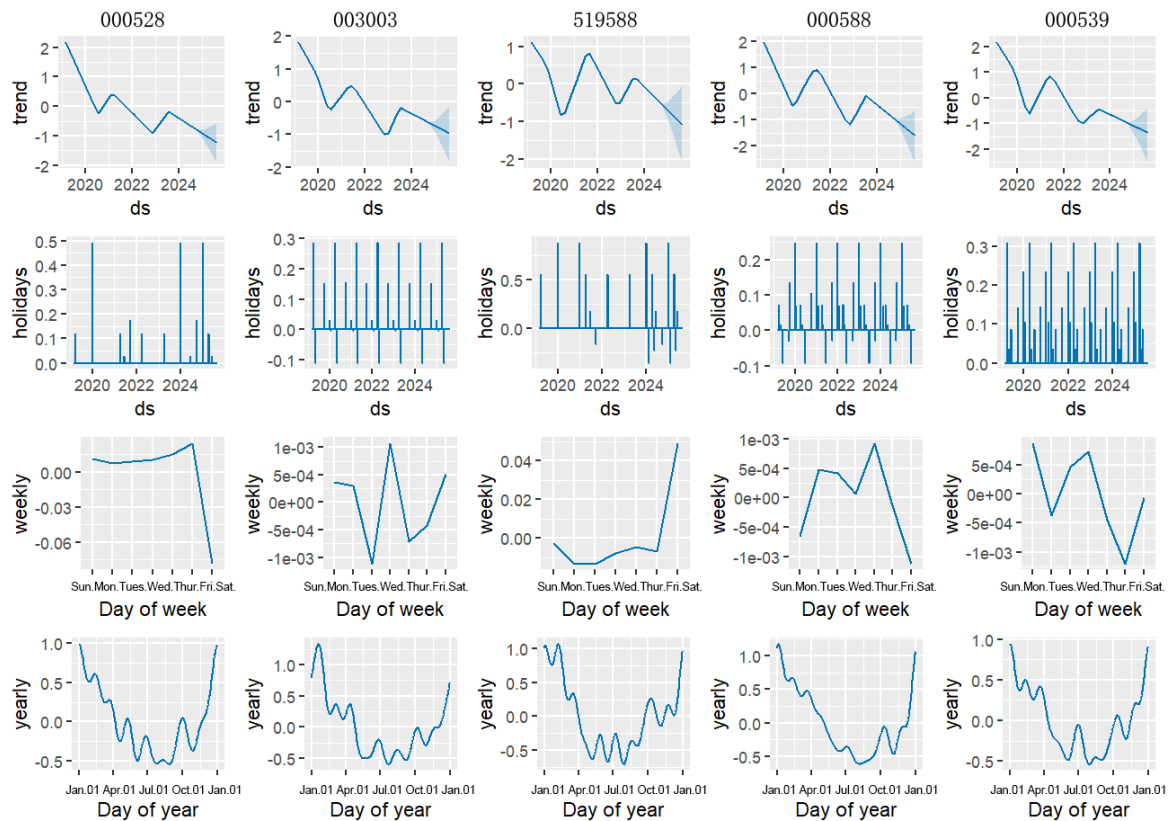


Figure 3 Decomposition of Prophet model prediction for fund-based financial product groups

4.4. Model testing

In order to assess the prediction accuracy of the Prophet model, this paper uses the metrics of Mean Absolute Error (MAE), Mean Square Error (MSE) and Root Mean Square Error (RMSE). The specific values are shown in the table below:

Table 4 Evaluation of model fitting effect

Affiliated categories	Fund Name	MAE	MSE	RMSE
Internet business-to-business financial products	Bosera Hopewell Currency B	1.4973	3.3082	1.8188
	GF Daily Red Currency A	1.3823	2.8962	1.7018
	ETF Cash Money	1.3624	2.8735	1.6951
	Harvest Call Money Currency A	1.3815	2.8229	1.6801
	South Cash Plus Currency A	1.2555	2.3769	1.5417
Bank-based financial products	Guangfa Currency A	1.3606	2.7377	1.6546
	Harvest Currency A	1.1776	2.2013	1.4837
	Xinhua YINBAO Currency A	1.1107	2.0130	1.4188
	Efatar Daily Wealth Management Currency A	1.3688	2.9164	1.7077
	Yinhua Currency A	1.2980	2.5596	1.5998
Fund-based financial products	ICBC Salary Currency A	1.2637	2.5543	1.5982
	Huaxia Cash Plus Currency AE	1.1986	2.3177	1.5223
	Bank of Communications Currency A	0.9572	1.4307	1.1961
	China Merchants Invitation Wallet Currency A	1.3060	2.8336	1.6833
	BOC Callable Treasure Currency A	1.4056	2.9110	1.7061

Note: The MAE, MSE and RMSE tables use normalized data.

As shown in Table 4, the analysis reveals that the lower indicator values for bank-based and fund-based financial products signify less volatility and greater regularity in returns, leading to higher prediction accuracy by the Prophet model. Conversely, the higher indicator values for financial products linked to Internet enterprises indicate greater return volatility influenced by various factors, resulting in lower prediction accuracy, although the model still effectively captures overall trends.

The Prophet model prediction plots for Bank of Communications Currency A (best fit) and Bosera Hopewell Currency B (worst fit) illustrate significant fluctuations in outliers across different financial products, as shown in Figure 4 and Figure 5. Due to varying market conditions annually, the Prophet model primarily captures broad trends, annual cycles, weekly patterns, and holiday effects, but has limited capacity to handle special cases and outliers. Nonetheless, the model remains accurate in predicting general trends. Bank of Communications Currency A, a fund-based financial product, exhibits minimal impact from outliers due to its low overall volatility, resulting in small prediction errors. In contrast, Bosera Hopewell Currency B, an Internet enterprise-linked financial product, shows higher return fluctuations, making predictions more challenging. However, the model still manages to predict its general trend effectively.

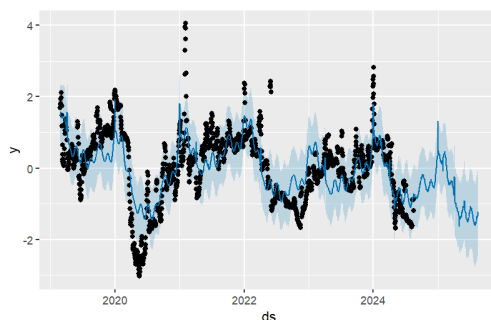


Figure 4 Bank of Communications Currency A Model Forecast

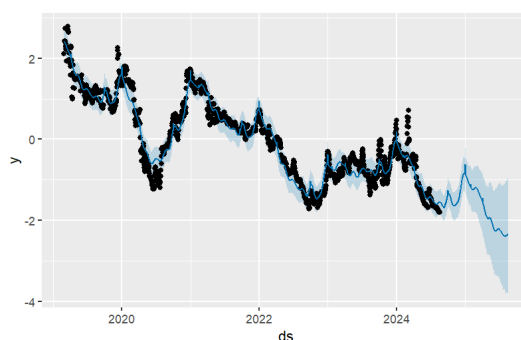


Figure 5 Bosera Hopewell Currency B Model Forecast

5. Research findings and policy recommendations

In recent years, Internet money fund, as an emerging financial product, has rapidly occupied a place in the market. Its convenient operation and relatively high yield have attracted a large number of investors. However, with the gradual maturity of the market and the intensification of competition, the volatility of returns of Internet money funds has gradually emerged. Especially in the context of market environment changes and policy adjustments, the risk management and return stability of Internet money funds have become the focus of investors' attention.

This paper can draw the following main conclusions by analyzing the Prophet model prediction of bank-based, fund-based and Internet business-to-business financial products: (1) Return Volatility: Bank-based and fund-based financial products have low return volatility, making them

stable and predictable. In contrast, Internet business-to-business financial products have high return volatility due to various factors, making predictions less accurate but reflecting their flexibility and innovation. (2)Trend Prediction: The Prophet model effectively captures long-term trends, annual cycles, and weekly patterns, providing valuable insights for investors.3.Holiday and Weekly Trends Impact: Internet financial products show less impact from holidays and weekly trends, likely due to long-term holding preferences. Bank-based and fund-based products exhibit significant volatility during these periods, influenced by liquidity management and investment strategies.

Based on the above conclusions, this paper puts forward the following suggestions:(1)Risk Management: Enhance risk management mechanisms for Internet financial products, improve market and policy monitoring, and increase information disclosure to reduce uncertainty. (2)Model Accuracy: Optimize the Prophet model to better predict outliers and unexpected events, and establish contingency plans for severe market volatility.3.Product Design and Education: Consider the impact of holidays and weekly trends when designing financial products, and strengthen investor education to improve decision-making during these periods.

Acknowledgments

This work was financially supported by Tianjin Foreign Studies University Innovation and Entrepreneurship Training Program. (Item number: 202410068250) fund.

References

- [1] MA Huizi,WANG Xiangrong,WANG Yixiao. Connotation, Characteristics and Risks of Internet Finance in the Chinese Context[J]. Research on Business Economy,2016, (21):165-167
- [2] WANG Yuting,MA Huizi,WANG Xiangrong. Research on the Risk Spillover Effect of Internet Money Funds on Commercial Banks[J]. Financial Theory and Practice,2019, (03):7-14.
- [3] Wang Jiahao. Research on the Influencing Factors of Internet Money Fund Yield[D]. Southwest University of Finance and Economics,2022.
- [4] Chi Y. Analysis of Risk Measurement and Influencing Factors of Internet Money Funds[D]. Donghua University,2022.
- [5] LI Zhipeng,YAO Xiaoyi. Comparison of return volatility risk of internet money funds in China[J]. Finance and Accounting Monthly,2015, (26):120-124.
- [6] Chen Ke,Zhang Jingwen. Research on the risk spillover effect of internet money market fund and financial market - based on GARCH-CoVaR model[J]. Financial Theory and Practice,2017, (09):41-46.
- [7] Wang Haiyan. Research on the influencing factors of balance treasure yield based on TVP-VAR model[D]. Northeast Agricultural University,2021.
- [8] Tian Ranran. Risk Analysis and Performance Evaluation of Internet Money Fund Products[D]. Tianjin University of Finance and Economics, 2023.
- [9] TAYLOR S J, LETHAM B. Forecasting at scale [J]. The American Statistician, 2018, 72(1):37-45.
- [10] WU Wenpei,SONG Yalin,WEI Shangfei. Research on electricity consumption prediction based on improved Prophet model [J]. Computer Simulation,2021,38(11):473-478.
- [11] XIONG Yingjie,DU Ning,WANG Li,et al. Study on the complementary value of MAIAC AOD over land in China based on Prophet-LSTM+P-Bshade fusion model [J]. China Science and Technology Paper,2024,19(08):877-883.
- [12] Xin Wei.Application of LSTM-Prophet hybrid model in material reserve demand forecasting [J]. Modern Computer,2024,30(04):53-57.
- [13] Ge Na,Sun Lianying,Shi Xiaoda,et al.Prophet-LSTM combined model for sales volume prediction [J]. Computer Science,2019,46(S1):446-451.
- [14] Min Hongyu. Risk measurement of internet money market fund products[D]. Changchun University, 2022.