

# *Analysis of the Fed Model in Investment and Potential Optimizing Strategies*

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**Abstract:** The Fed Model, a widely discussed investment model, has played a pivotal role in shaping investor perceptions and asset allocation strategies. This article conducts an in-depth analysis of the Fed Model's performance and its relevance in contemporary investment decision-making. By examining the logics behind and the factors it relies on, this study sheds light on the strengths and limitations of the Fed Model. Considering the logics behind the terminology "investment" and the choose and calculation of variables, this article explores potential optimizing strategies that can enhance the effectiveness of the Fed Model in guiding investment decisions. The findings of this research offer valuable insights for investors, financial analysts, and policymakers, helping them navigate the complexities of financial markets and make informed decisions in an ever-evolving investment landscape, and moreover, the reasons for the steps taken towards to goal.

## 1. Introduction

All expected utility decision makers, regardless of their attitudes towards risk, like the gains of the gamble and dislike losses [1]. Investment, a word that merely sounds more pleasant than gamble does, shares common characteristics with gambling that the pursuit of favorable returns is often accompanied by a careful evaluation of risk. Investors, financial analysts, and economists have long grappled with the concept of "utility" in investment, seeking a delicate balance between rewards and the associated risks. Utility usually exhibits a nonlinear relationship with the physical reward value that corresponds to risk attitudes and reflects the increasing or decreasing marginal utility obtained with each additional unit of reward [2]. The core principle underlying utility in investment is expressed as:

$$\text{Utility} = \text{Rewards} - A * \text{Risk} \quad (1)$$

This equation lays the foundation for assessing various strategies to mitigate investment risk, a crucial aspect of constructing a robust portfolio. As we introduce the 3 types of risk assessment strategies, we will introduce our topic – Fed Model – which utilizes the most rarely seen strategy, risk neutral.

One of the prominent models that have shaped investment decisions and asset allocation strategies is the Fed Model. Widely used in the 80s to 90s in US stock markets, Fed model was deeply rooted in economic theory and historical market data, and offers a framework for investors

to choose between stocks and bonds based on key variables such as bond yields and earnings yields. As we delve into the logics behind the Fed Model, we will explore how these variables are calculated and how the model's limitations have impacted its effectiveness in guiding investment choices.

Beyond the Fed Model, this article will also venture into the realm of optimizing strategies. It delves into methods such as replacing bond yields by money market fund yields and using EBITDA/Price rather than earnings yield, which better reflects the profitability of a company, aiming to provide investors with valuable tools to navigate the complex landscape of investment.

In this comprehensive exploration, we aim to shed light on the fundamental concepts underpinning utility in investment, dissect the Fed Model's mechanics, and unveil optimizing strategies that can empower investors to make informed and strategic investment decisions in an ever-evolving financial landscape.

## 2. Utility in Investment

First of all, what is the investment return and how the utility function (Utility = Rewards – A\*Risk) I mentioned was formulated. Mathematically speaking, we could formulate it by the following equation:

$$U = r - 0.005\lambda*\sigma^2 \quad (2)$$

Where U refers to utility, r refers to rewards,  $0.005\lambda$  refers to A, where we could understand it as our risk coefficient, and  $\sigma^2$  refers to the risk, which represents variance as well. Then we will study the reason variance represents the risk of investment, and how is 0.005 generated.

$$E(x) = \int x*f(x) dx \quad (3)$$

Above is the expected return, or expected value formula, which is the integration from infinity to negative infinity of  $x*f(x)$ , also representing the average value. This is the first moment form, while the second moment form is:

$$\text{Var}(x) = \int (x-\mu)^2*f(x) dx \quad (4)$$

This represents the variance. The third and fourth moments of the formula do exist and are simply raising the power of  $(x-\mu)$  to 3 and 4. Considering the probability distribution graph, we know that the expected value represents the middle point – mean. The variance means the difference between the mean value and the actual value, which represents the gap between the left part and the right part of a probability distribution graph. While for the third moment, as an odd function, it's widely used to observe the general trend of the graph. The fourth moment, which is an even function again, simply magnifies the gap, existed in the variance function, generally used to measure the value at the peaks. However, the third and fourth moment function will not be needed for our research.

Back to our formula of  $r - 0.005\lambda*\sigma^2$ , it's easy to notice that these two terms r and  $0.005\lambda*\sigma^2$  on the same side while being different moment doesn't make sense, so 0.01 will need to be added into the formula to even the moment of r and  $\sigma^2$ . During the differentiation process, r will be differentiated to 1, and  $\sigma^2$  will become  $2\sigma$ , so another  $\frac{1}{2}$  will need to be multiplied into the formula.  $0.01 * \frac{1}{2} = 0.005$ , this proves the 0.005 in the formula. However, mathematically speaking, the value of  $\lambda$  ranges from infinity to negative infinity, as the result, 0.005 could be completely covered in  $\lambda$ , which represents the risk coefficient. The reason for keeping 0.005 in the formula is to make it easier for the researchers to understand the logics behind and better utilize the formula.

### 3. Different Risk Assessment Strategies

Risk assessment is considered as the process of making a recommendation on whether existing risks are acceptable and the present risk control measures are adequate [3]. There are 3 different types of risk assessment strategies, which are risk seeking, risk averse, and risk neutral.

To explain these 3 terminologies using an extremely straightforward example is that imagine we have 2 investment plans A and B. For A, there will be a 50 50 chance of losing 100 dollars and winning 100 dollars. For B, there will be a 50 50 chance of losing 50 dollars and winning 50 dollars. The expected returns from both plans are the same,  $0.5*100+0.5*(-100) = 0.5*50+0.5*(-50) = 0$ . As they have the same expected return, a risk seeking investor will choose A and a risk averse investor will choose B. Correspondingly, in the formula we explained before, the value of  $\lambda$  will range from negative infinity to 0 for plan A, and from 0 to infinity for plan B. Imagine having negative infinity for  $\lambda$ , then  $-0.005\lambda*\sigma^2$  will be infinitely large, resulting in infinitely large utility. This is saying that higher risks, brings higher utility, and less rewards are considered. For plan B, when the same logics apply, it becomes easier to understand the term risk averse.

Except for these two cases, there is another case where  $\lambda = 0$ , which corresponds to the third terminology – risk neutral. With  $\lambda = 0$ , the formula becomes  $U = r$ , meaning that only the rewards are considered into the case. In other words, for risk neutral investors, they consider nothing but the expected return. In the example above, plans A and B have the same expected return. Therefore, both plans will bring a risk-neutral investor the same result. Moreover,  $\lambda = 0$  is the precondition for Fed Model to be utilized.

### 4. Fed Stock Valuation Model

Fed Model is a model that considers nothing but the expected return. To explain Fed Model shortly is that imagine you have 100 dollars, and Fed Model will tell you to spend these 100 dollars on stocks or bonds. The term "Fed model", or "Fed Stock Valuation Model" (FSVM), was coined in a series of reports from 1997 to 1999 by Deutsche Morgan Grenfell analyst Dr. Ed Yardeni [12]. Back in time, they were using the forward earnings yield on the S&P 500 Index and the 10-year Treasury yield to build the Fed Model, assessing the levels of equity market over-or under valuation.

Then why is the earnings yield and bond yield are utilized as the 2-major variable in Fed Model? There are 2 reasons for that. "15 years of policy-driven easy money has produced an overheated economy and financial risk-taking that makes sense only in a zero-interest rate environment. The recent history of interest rates compared to inflation and of stock prices compared to stock market volatility suggests that the economic policies of the past 15 years, like the economic policies of the mid- '60s and '70s, have been so expansionary that they may create the unfortunate outcome of stagflation." [4], this saying from Dew shows that the stock market and bond market back in the 80s were not as mature and complex as it is now, meaning that less risk and variables will play crucial roles in investment analysis. As the most effective period for Fed Models was during the 80s to 90s, the minor complexity of the market built the platform for Fed Models to merely use earnings, yield, and bond yield and not considering other risks and variables.

The second reason is as we know that the market back in time was less complex, the central bank will sort of have more "power" to control the market by changing the interest rate, which strengthens the correlation between earnings yield and bond yield. To be more specific, for example, the central bank decides to lower the interest rate to push economy. As the rates lowered, more cash will be available on the market for investors, and the stock prices will rise. Earnings yield is Earnings Per Share (EPS)/Price. As the price rises, the earnings yield will drop. Also, the lowered interest rate will directly lower the bond yield, which strongly proves the positive correlation

between earnings yield and the bond yield back in time. Any statement that justifies high P/E ratios with the existence of prevailing low interest rates is essentially using the Fed model [13]. This line from Professor Estrada of Wall Street marks our proof of the strong correlation between earnings yield and bond yield, as P/E ratio is the reciprocal of earnings yield, and interest rates directly affect bond yield.

Besides all these reasons, the simple and understandable principle of Fed Model and its common “big buy signal” made it become one of the favorite models for investors and bears. Since using this model, it’s not only convenient but easy to understand for them to convince their clients that the stock market or bond market will come to rise or fall in the near future.

## 5. What does Earnings Yield and Bond Yield represent?

Returning to the 2 variables used in the Fed model, as we mentioned, the earnings yield is  $EPS/P$ . EPS stands for Earnings Per Share, which means the profit of a company per share, a variable that could considerably represent the profitability of a company. P stands for Price, which is the stock price. Then  $EPS/P$  will be a variable that could symbolize the rate of return of purchasing this stock, and the reciprocal of the P/E ratio as well. For Bond Yield, the full name should be 10-Year Forward Bond Yield, also known as Yield to Maturity (YTM). “The term yield to maturity (YTM) refers to the total return anticipated on a bond if the bond is held until it matures. Yield to maturity is considered a long-term bond yield but is expressed as an annual rate. In other words, it is the internal rate of return (IRR) of an investment in a bond if the investor holds the bond until maturity, with all payments made as scheduled and reinvested at the same rate.” [5]. In other words, Bond Yield means the total profit of holding the specific bond until it matures and expressed as an annual rate, which is utilized in all Fed Models, including the model I used that I will discuss later. Furthermore, the data utilized in my models are effective interest rates (real rates that were recorded in the past, not the nominal rates determined by the central bank). It is concluded that the yield to maturity determined by the nominal interest rate method in research may lead to incorrect results, in contrast to the yield to maturity in the form of an effective interest rate. [14]

We need Fed Model to predict trends in the future. Meaning that we know the value from  $X_0$  to  $X_T$ , and we need to know the value of  $X_{T+1}$ , where T is a time variable. Since the Bond Yield is a definite value that was designated by the central bank, it’s more of a future non-predicted variable. For the Earnings Yield, there are data for predicted EPS and price published by securities corporates and research institutions. As considering the copyright, I have been using the past data of both EPS and P to build the model of the past for the sake of accuracy. Using predicted values or past values both for EPS and P at the same time will improve the accuracy of our model and prediction.

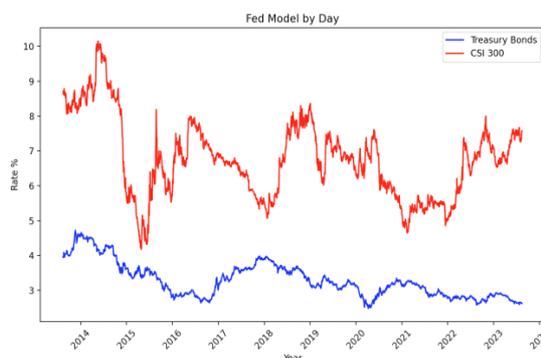


Figure 1: Fed Model of CSI300

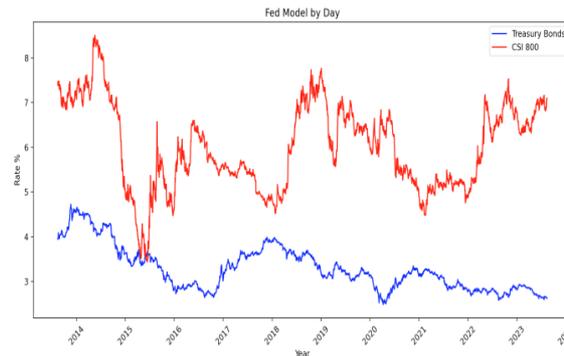


Figure 2: Fed Model of CSI800



Figure 3: Fed Model of CSI500

The 3 graphs above are the Fed Model built using China’s 10-Year Bond Yield versus Earnings Yield on CSI300, CSI500, and CSI800 Indices from China’s A Share Stock Market, representing leading enterprises, small and medium-sized enterprises and the vast majority of enterprises separately. As we can tell that Figure 1 and Figure 2 shares similar trends. This is most likely because that CSI300 is the leading enterprise in the A share market, which holds the majority of stock and cash flows in Chinese stock market. Its strong influence resulted in similar graphs for CSI300 itself and CSI800, which includes the vast majority of enterprises. Moreover, considering the fact that the earnings yield is able to keep pace with the economic growth of China, while the bond yield isn’t, which will be discussed in the next section, are the reasons for the poor correlation in Figure 1 and 2.

Figure 3 for CSI500 somewhat tells a different story. My conclusion from this graph is that the CSI500 will have a rise in stock price in the next few years. First, if we look at the blue line, representing the Bond Yield. It’s clearly that it is gradually dropping, but with a gradual reduction in fluctuations as well. This is indicating that in a few years, the bond yield will be at some point between 2 to 3, closer to 3. As we look back to the entire graph, since 2014 to the present, there isn’t many intersections between the 2 lines, but there is one crucial point that we could notice is that the 2 lines are correlated. Despite separating from each other after each intersection, the trend still exists such that these 2 lines are gathering. During the time between 2022 and 2023, we can see that it’s a rise for the CSI500, generally speaking. As we mentioned, the fluctuation in bond yield is reducing, meaning that CSI500 will come to at least a slight drop in order to gather with the bond yield, the blue line, giving the precondition that Fed Model is still effective. Then how does the drop in CSI500 result in a rise in the stock price? As we know that the earnings yield is  $EPS/P$ , while  $EPS$  isn’t a variable that could have a drastic fluctuation in a short period of time as it represents the profitability of a company (unless the company broke). As a result, in order to have

the earnings yield drop, the only possibility is a rise in stock price, P. This is the reason for my conclusion for the rise in stock price for CSI500. Returning to the negative correlation of the 2-line, which does not agree with the previous definition of the Fed model, the reason can be derived as follows. We demonstrate that at low levels of the real bond yield, the correlation between the equity and bond yields turns negative [15]. We will be discussing more about the negative correlation in the optimization plan section.

## 6. Limitation on Fed Model

The period when the Fed model was most effective was the 80s to 90s, which was 30 to 40 years ago. During this long period of time, no matter China or internationally speaking, the stock market has already been a lot more mature than before. Maturity means more factors should be considered in the investment strategy, and more risk would be taken with the same investment strategy in the past. Fed Model is such a model that considers nothing but the expected return, of course starting to gradually lose its effectiveness.

Secondly, as I mentioned before, the Chinese 10-Year Bond Yield isn't able to keep pace with the economic growth. Below are the 2 graphs that I cited from the article "Why is China's bond yield so far below economic growth?" by Professor Pan. Figure 4 is the graph for US 10-Year Bond Yield versus US nominal GDP Growth, which we can tell is strongly correlated. Figure 5 is the graph of Chinese 10-Year Bond Yield and Chinese nominal GDP Growth, while the red line on the bottom is the bond yield and the blue line on the top is the GDP growth, which is extremely plain, that clearly the bond yield isn't able to keep pace with the GDP growth.

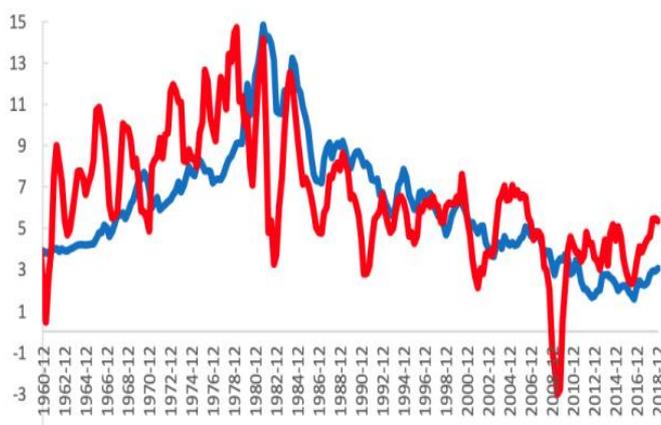


Figure 4: US 10-Year Bond Yield & Nominal GDP Growth

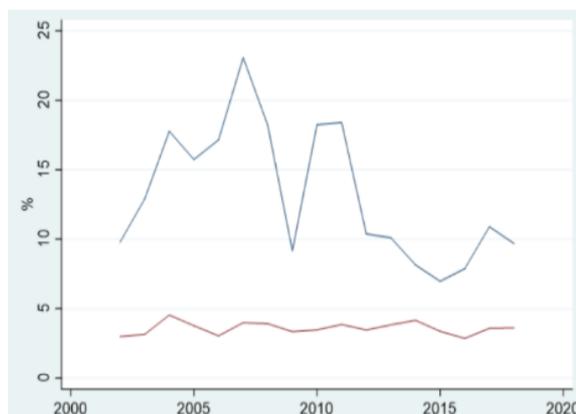


Figure 5: Chinese 10-Year Bond Yield & Nominal GDP Growth

The reasons for this could be concluded below. “China began interest rate marketization in 1996. Although it has nominally completed interest rate marketization reforms, the financial market is still not perfectly competitive. Further progress in interest rate marketization is needed, which is also one of the important reasons why China's government bond yields are lower than economic growth rates” [6]. As the existence of capital market regulation in China, the interest rate hasn't been able to climb up as GDP does.

In recent years, China's savings rate has been around 50%, ranking first in the world [7]. The exceptionally high savings rate in China has caused the low interest rate, as higher the savings rate, the more effort the central bank will need to lower the interest rate to push economic growth and to lower the inflation rate. The Figure 6 below is cited from Professor Pan's article of 10-Year Bond Yield versus savings rate, showing that higher the savings rate, lower the bond yield will be, as the bond yield is directly related to the interest rate.

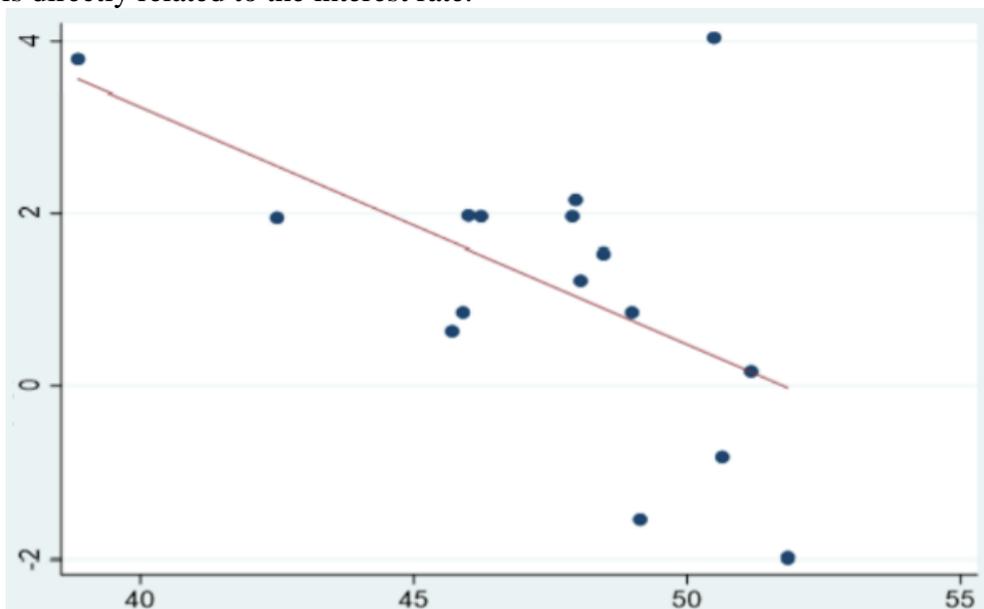


Figure 6: Higher the Savings Rare Lower the Bond Yield

Then what are the potential causes for the high savings rate in China? In China, the issues of expensive healthcare and difficulty in accessing medical treatment have become the top concerns of the Chinese population [8]. In a country where accessing medical treatment has become the top concern, the world number one savings rate seems to be more sensible. Not only the insurance system in China has been corrupted, but also the policies related to treatment and welfare system, which will not be discussed further in this article.

We have been exploring the limitation on Fed Model caused by Bond Yield, then what about the earnings yield, is there any possible alternation of this that could make Fed Model more suitable to Chinese market or international market? EPS, is the earnings per share has been used to represent the profitability of a company. Possible substitutions for earnings yield are dividend yield, or we could even use EBITDA to substitute EPS, which might better present the profitability of a company. While using these variables, there are more problems taken into concern. For example, the dividend payout ratio, which is comparatively low in China. Moreover, for different industries, the dividend payout ratios are different, resulting in different P/E ratios, which could affect the accuracy of the model. We will discuss further about the optimization plan for earnings yield in the next section.

## 7. Optimization Plan

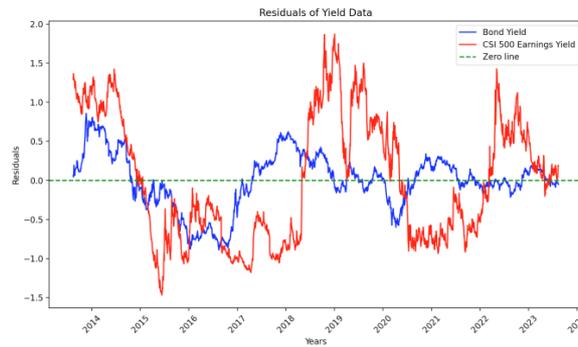


Figure 7: Residual Plot of Fed Model of CSI500

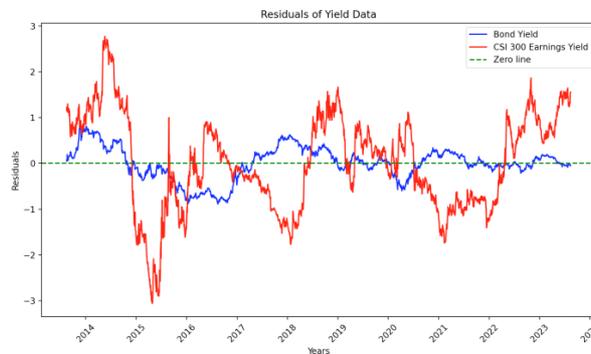


Figure 8: Residual Plot of Fed Model of CSI300

Figure 7 and Figure 8 above are still Fed Model of Bond Yield versus CSI500 and CSI300. The question here may be what made the two lines a lot more correlated than before. I removed the trend line from both sets of data. This means that like I mentioned, the bond yield has a trend of dropping because of savings rate and capital market regulations and so on, therefore, I removed all these factors that could cause systematic errors on the graph. This is a graph showing merely the fluctuation of both data sets. An easier way to understand the graph is the differentiated graph. As long as the value is positive, it means that the actual value is rising, vice versa.

Figure 7 is the CSI500 earnings yield versus bond yield. Before 2017, the trend is hard to conclude, but we can see that after 2017, the trend is mostly whenever the bond yield is positive (rising), the earnings yield will be negative (dropping). As the bond yield becomes negative, the earnings yield will come to positive again, which proves the argument I made before about 2 lines gathering at the end. However, this doesn't obey to the logics I mentioned when I first introduced Fed Model, that the 2 lines should be positively correlated. This is because of the limitation presented, that the low effectiveness and the low pace or even negative growth of bond yield have led to this outcome.

Figure 8, we can see that the earnings yield of CSI300 ranges from 3 to -3, where CSI500 (Figure 7) only ranges from 2 to -1.5, which means greater fluctuation, and higher risk. If we throw back to the equation of utility at first, we have explained that higher the risk ( $\lambda$ ), higher the utility, which agrees with the statement that the leading industries (CSI300) possess the vast majority of stocks and cash flows and the strongest profitability.

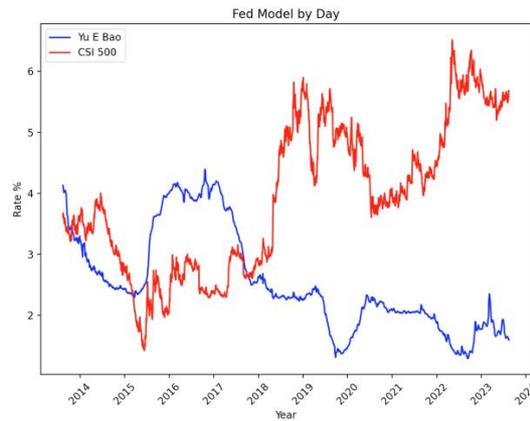


Figure 9: 7 Days Annual Growth Rate of Yu E Bao and Earnings Yield of CSI500

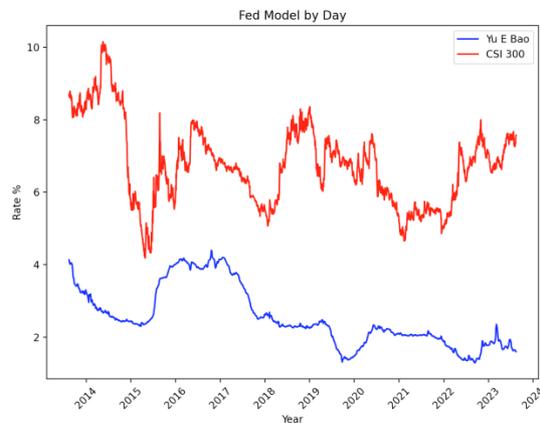


Figure 10: 7 Days Annual Growth Rate of Yu E Bao and Earnings Yield of CSI300

We have been talking about optimization substitution for bond yield, so I chose the monetary funds as a substitution, as the monetary fund shares similar characteristics with bonds. They are all investment strategies with almost 0 risk in China. As I wasn't able to find suitable data for the monetary fund index data, I chose Yu E Bao, one specific monetary fund in China that's ranked number one for its volume, to build this model. Figure 9 and Figure 10 above are the altered Fed Model that I built using 7 days annual growth rate of Yu E Bao with CSI500 and CSI300. From Figure 9, we can clearly tell that the monetary fund has a striking difference in fluctuations compared to the bond, while a similar trend that it's gradually dropping. Moreover, according to the graph, we can tell that the monetary fund yield is inversely proportional to CSI500. As the conclusion we made before (Figure 3), with the precondition that Fed Model is still effective, that CSI500 will have a rise in stock price, and a drop in earnings yield, since the inverse relationship between CSI500 and Yu E Bao, we suspect that there will show a trend of rise in the annual growth rate for Yu E Bao in a few years. Even though I mentioned that the monetary fund has a similar trend with bond yield such that it's gradually dropping, but a comparative rise will occur if the model is still effective. The graph on the right, however, appears to be far less correlated, which I believe is also the reason for the CSI300's dominant power [16-17].

After the discussion about bond yield, there are also some possible substitutions for the earnings yield to build a better model. However, due to time constraints, I wasn't able to actually build models for the following substitution.

Earnings yield is  $EPS/P$ , where EPS is the fundamentals variable, and Price is the market factor related variable. We will want to keep the market factors in our model, so the possible substitutions

for EPS are EBITDA and dividend. Investors and creditors often assign greater importance to EBITA and EBITDA results than EPS [9]. EBITDA stands for earnings before interest tax depreciation amortization, which in my opinion, is a better variable than EPS in showing a company's profitability, and might generate a more correlated graph displaying more predictable factors. While for dividend yield, it considers the dividend payout ratios, which are comparatively low in China. "The average dividend payout ratio – total dividend paid to shareholders divided by profit – jumped to nearly 30 per cent in China in 2021 from 15.5 per cent in 2012" [10]. Even though it has jumped to 30 per cent, a dividend payout ratio of 30%-50% is considered healthy from GoCardless [11]. Moreover, for different industries, we need a different model to analyze when using dividend yield. For example, in securities industry, they normally have a high dividend payout ratio, while for semiconductor industry; a low dividend payout ratio is expected as the majority of their profits will be conducted to research and development.

## 8. Conclusion

In conclusion, the analysis of the Fed Model has provided insights into its performance and relevance in investment decision-making. While the model has played a significant role in investment strategies, its limitations and evolving financial markets require a more nuanced approach. The Fed Model's historical significance in the US stock market cannot be denied, but its applicability in today's diversified investment field is subject to debate. The model's reliance on bond yields and earnings yields as key variables offers a framework for choosing between stocks and bonds, but its effectiveness has been tempered by changing market factors.

To enhance the Fed Model's utility, we have explored potential optimizing strategies, such as considering monetary fund yields and using EBITDA/price ratios. These strategies aim to provide investors with more accurate tools to make informed decisions in a world where financial markets are constantly evolving.

In navigating the complexities of investment, it is essential to strike a balance between risk and reward, recognizing that utility is a dynamic concept that varies with individual risk attitudes. The Fed Model, while a valuable tool, should be viewed in conjunction with other approaches and adapted to suit the unique challenges of the modern investment landscape. This comprehensive analysis equips investors, financial analysts, and policymakers with the knowledge to make strategic decisions that align with their objectives and understand the logics behind the decisions. As we move forward, it is imperative to embrace a flexible and adaptive approach to investment strategy, recognizing that there is no one-size-fits-all model in the pursuit of financial success.

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