

In depth analysis of Fisher model and explore its limitation

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Abstract. This paper shows how people develop the concept of time value of money or the interest rate in the financial market model, how to derive individual savings decisions from corporate investment decisions, and why the net present value rule applies to decision-making. Specifically analyze the relationship between capital market line and Fisher model. And based on the Chinese stock market to further study the Fisher model and show its role.

Keywords: fisher model, investment, capital market line, cash flow, rate of inflation, returns of stock.

1. Introduction

Fisher model is an economic theory founded by economist Owen Fisher. It describes the relationship between inflation and real and nominal interest rates. Fisher model shows that the real interest rate is equal to the nominal interest rate minus the expected inflation rate. Therefore, the real interest rate will decrease with the increase of inflation, unless the nominal interest rate is the same as the growth rate of inflation.

The Fisher Equation reflects that the real interest rate can be calculated by subtracting the expected inflation rate from the nominal interest rate. In this equation, all offered interest rates are compound. Fisher model can be seen every time you go to the bank; The interest rate of investors' savings accounts is actually the nominal interest rate. For example, if the nominal interest rate of a savings account is 5% and the expected inflation rate is 4%, the funds in the savings account actually grow at a rate of 1%. From the perspective of purchasing power, the lower the real interest rate, the longer it will take for savings deposits to grow significantly.

For decades, Fisher model has been regarded as one of the foundations of enterprise financing. Fisher model (1930) assumes in its classical form that there is a financial market that allows individuals to transfer money between different dates at a known interest rate. Let these dates be called "now" and "then". Individuals have a preference for consumption now and then. They can realize these choices by saving or saving, or by borrowing in the financial market. Everyone will make the consumption choice of redistributing personal income stream. This choice is to maximize utility, but is subject to budget constraints, which limit the choice to those who make the present value of consumption flow equal to the present value of income flow. The model is developed for a certain rate of return in the financial market.

Suppose the consumer stands at date zero and makes the choice of distribution the income and consumption of two dates $t = 0$ and 1 , which we call from time to time. Consumers now have some income then let $m = (M_0, M_1)$ represent income pair. Similarly, let $C = (C_0, C_1)$ Indicates consumption pair; each pair represents us dollars. Suppose that consumers can borrow at a known interest rate R When consumers choose to consume, they will also make the decision of saving $s_0 = m_0 - c_0$; The selective rate of return on savings $(M_0 - C_0) (1 + R)$ is USD. This consumers must make consumption choices consistent with the budget limit

$$c_0 + \frac{c_1}{1+r} = m_0 + \frac{m_1}{1+r}$$

Figure 1. Calculation formula of rate of return

Since there is no uncertainty, all financial assets must produce the same rate of return. therefore

It is logical to assume that there is only one financial asset and one market. This will change over time uncertainty is introduced. *Richard (2008)*

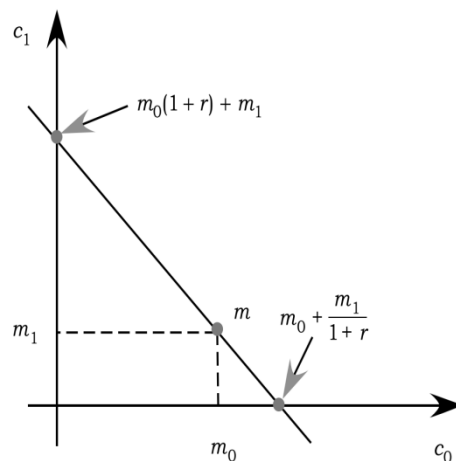


Figure 2. The graphic of fisher model

2. Fisher model

2.1 Development of Fisher model

2.1.1 Allow consumers to participate in the market

In the market, individual savings decisions are characteristic. Some people are willing to take higher risks to get higher returns. Some people choose conservative investment with less risk and less return, but it is not easy to make mistakes.

2.1.2 Lead into investment frontier

The model gives consumers the role of business owners. Although the NPV rule has not been derived, it is assumed that the owner uses the rule to make investment decisions on behalf of the company. This investment decision is on capital goods, not on financial assets.

2.2 Restore personal savings decisions

Individuals have two roles, one is the consumer, the other is the owner of the company. Under constraints, individuals can make two kinds of decisions to maximize the expected utility. Net present value is assumed here. Allow individuals to make investment and savings decisions as owners of the company. In the financial market as a consumer, personal savings and investment decisions have characteristics. In the first and third steps, individuals are considered to act in their own interests. *Richard (2008)*

3. Cashflow

Cashflow is closely related to Fisher model. It can be said that there will be further Fisher model with cash flows. So what is cash flow,

Cash flow is the amount of cash in and out of the company. The enterprise obtains income from sales and uses the funds for expenditure. They may also earn income from interest, investments, royalties and license agreements, sell products on credit and expect to actually receive the cash owed later. *American Express(2021)*

Cash flow can be positive (more cash flows in than out) or negative (more cash flows out than in). Negative cash flow will bring higher financial risk to enterprises of all sizes and types, especially because a company may have negative cash flow while generating profits.

Positive cash flow indicates that the company's current assets are increasing, enabling it to repay debts, reinvest its business, return funds to shareholders, pay expenses, and provide a buffer for future financial challenges. Companies with strong financial flexibility can take advantage of profitable investments. They also performed better during the downturn because they avoided the cost of financial distress.

One of the most important sources of financial uncertainty is the amount and timing of cash flow. This is critical to assessing the company's liquidity, flexibility and overall financial performance.

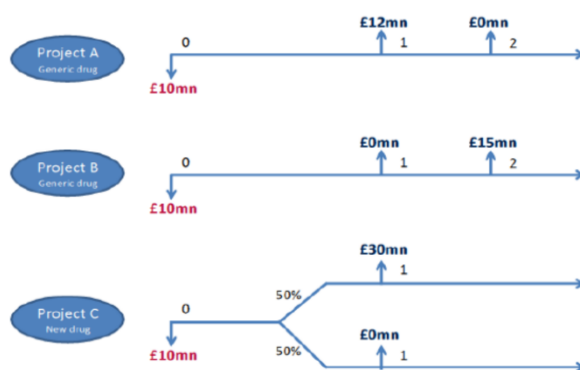


Figure 3. Chart of cash flow

4. Capital Market Line

The capital market line (CML) represents the portfolio with the best combination of risk and return. It is a theoretical concept that represents all portfolios that best combine risk-free return and risk asset market portfolio. Under the capital asset pricing model (CAPM), all investors will choose a balanced position on the capital market line, that is, borrowing at a risk-free interest rate, because this will maximize the return at a given risk level. *John and Luis(2001)*

In theory, a portfolio that meets the capital market line (CML) optimizes the risk / return relationship to maximize performance. The capital allocation line (CAL) allocates risk-free assets and risk portfolios to investors.

CML is a special case of CAL, in which risk portfolio is market portfolio. Therefore, the slope of CML is the sharp ratio of the market portfolio. Generally speaking, if sharp ratio is higher than CML, purchase assets; If the sharp ratio is lower than CML, sell the assets.

Unlike the more popular efficient frontier, CML includes risk-free investment. The intercept points of CML and efficient frontier will produce the most efficient portfolio, which is called tangent portfolio.

As investors move up CML, the risk and return of the overall portfolio will increase. Risk averse investors will choose portfolios close to risk-free assets and tend to have low variance rather than high return. Investors with low risk aversion will prefer portfolios with higher CML and higher expected returns, but the difference is large. By borrowing at a risk-free interest rate, they can also invest more than 100% of their investable funds in high-risk market portfolios, thereby increasing the expected return and the risk of exceeding the market portfolio. *John and Luis(2001)*

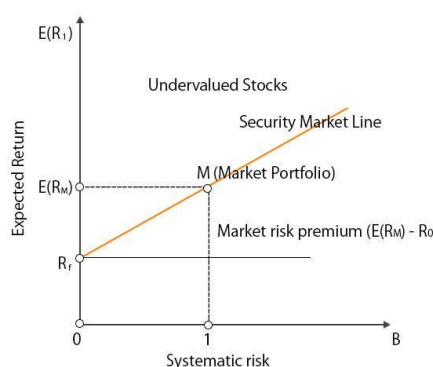


Figure 4. CML (Capital Market Line)

5. Empirical test of Fisher model in Chinese stock market

After the empirical test of Fisher model on stock return and inflation rate in the United States, it is concluded that in the short term (one year), the real stock return does not change the inflation rate

In response, there is a positive relationship in the long term (5 years). The monthly and quarterly (short-term) negative correlation is obtained under the China empirical test. Take the five-year span (long-term) score. This shows that investors' speculation in the stock market (within one year) can not avoid inflation, but only long-term (5 years or more) investment.

Fisher model is the nominal return of assets. The relationship between inflation rate and expected inflation rate is explained as follows: The nominal return on assets should move in the same direction as the expected inflation rate dynamic, that is, in equation $I = a + \beta\pi_t + e$, the variable is α, β . Where, I stands for the rate of return, π_t stands for the rate of inflation. If the expectation passes. There is a one-to-one relationship between commodity inflation rate and stock return rate, then The estimated value of β is approximately equal to 1, in which case, expected inflation every 1 percent increase in inflation will lead to a 1 percent increase in stock returns.

We can also clearly see from the derivation of Fisher Equation below: Fisher model for nominal rate of return (NR), actual rate of return (RR). The relationship with inflation rate (IR) is expressed as follows: $[(1+NR)/(1+IR)]-1=RR$, in order to simplify the calculation, we can use nominal income. Rate of return minus inflation rate to estimate the actual rate of return: $NR-IR=RR$. That is, $nr=ir+rr$. financial economists also think that: Stock Returns, Profit rate and inflation rate should be positively correlated, because stocks represent tangible or The ownership of real assets, inflation can stab to a certain extent to stimulate economic growth, stock returns should also increase. Therefore, stocks can as a possible hedge against inflation. But the crux of the matter is that inflation has a double effect on the stock market the heavy effect can stimulate and suppress the stock market. In fact, scholars at home and abroad have debated this for a long time, and finally admitted that: By stages, in the initial stage of inflation, the money supply grew abnormally and other factors. There is a force to promote the rise of stock prices. While in the case of inflation in the continuation and climax stage, under the policy pressure of monetary contraction, the stock price. However, in adhering to their respective positions, there are few empirical tests.

Selected Shanghai Composite Index: December, 1990—The closing price on the last trading day of each month in December 2004 is taken as Y in the CPI index of the month is selected for price and inflation. The data comes from China Statistics (1990-2004), a total of 169 monthly data and 69 quarterly data meet the inspection requirements, the selection of real estate index from January 1997—The closing price on the last trading day of each month in December, 2005 price and inflation select the monthly CPI index, a total of 108 monthly data (since the real estate index was officially released on June 13, 1993, and Data collection before 1997 was difficult, so only monthly analysis was conducted.)

-Data segmentation

At the beginning of the establishment of China's stock market, the market scale was small, and the price was controlled by the market makers and policies have a great impact. After 1996, it became more and more stable because promulgation and implementation of the following policies: the stock market was established until december1994. The t+o settlement system was implemented on December 31, 1996, and the t+i settlement system was implemented on december 15, 1996. The settlement system was implemented. On January 6th, 1999, the price limit trading was implemented, the securities law of the people's Republic of China was promulgated on july1,1999 to reflect these changes, the sample is divided into sections:

December1990 - December2004
December1994 - December2004
February 1995 December 2004
January1996 - December2004
December1996 - December2004
July, 1999 - December, 2004, 6 paragraphs in total
-Abnormal value handling

For example, April 30th, 1992 and the next trading month may, 1992 September 29, the index soared from 445.38 to L, 234.71, and its data fluctuated empirical test of Fisher model in Chinese stock market 29 if it is too large, it is an abnormal value. However, this paper starts from the facts and does not consider eliminating it

-Data processing

For the monthly yield, the next month's share price is subtracted from the current month's the share price is divided by the share price of the current month and the effect of inflation rate is deducted, i.e $I = i / I - 1$, 10000, 1. the same treatment shall be made for the quarterly yield. For the month the inflation rate is directly obtained through C IV, i.e

10000, =cpi, one CPI, the inflation rate in the first quarter, using the current CPI except subtract C IV with a delay of three months. *Jacob and Matthew(1993)*

-Results of empirical test

Relationship between variables and models: $i = a + \text{anus} + e$ generation I the actual rate of return in the table represents the inflation rate, which is the proposed the OLS method is used. The following results are obtained by using the data of China:

Table 1. Relationship between China's inflation rate and stock return (monthly and quarterly)

Period	α_1	β_1	α_3	β_3	F-statistic Month	F-statistic Quarter
1990.12—2004.12	0.027289 (1.722741)	-1.024139 (-99.03292)	0.049305 (1.794421)	-1.021995 (-85.30015)	9807.518	7276.116
1994.12—2004.12	0.008393 (1.130525)	-1.001358 (-173.1855)	0.015473 (0.958864)	-1.006712 (-115.2430)	29993.21	13280.94
1995.12—2004.12	0.010521 (1.429934)	-0.998542 (-132.2825)	0.020223 (1.201489)	-1.004940 (-84.28672)	17498.65	7104.251
1996.1—2004.12	0.010391 (1.408160)	-1.005359 (-80.11910)	0.020100 (1.189489)	-1.015033 (-57.08556)	6419.070	3258.761
1996.12—2004.12	0.005521 (0.768461)	-1.002672 (-84.02905)	0.011728 (0.678572)	-1.009613 (-56.34168)	7060.882	3174.384
1999.7—2004.12	-0.003249 (-0.473667)	-0.979899 (-84.19517)	-0.007108 (-0.477473)	-0.983533 (-63.25635)	7088.827	4001.365

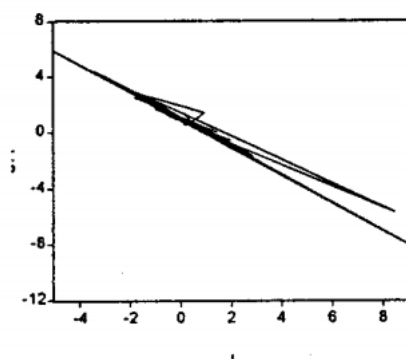


Figure 5. Correlation diagram of CPI and I

Note: CPI and I in the figure represent inflation rate and return rate respectively

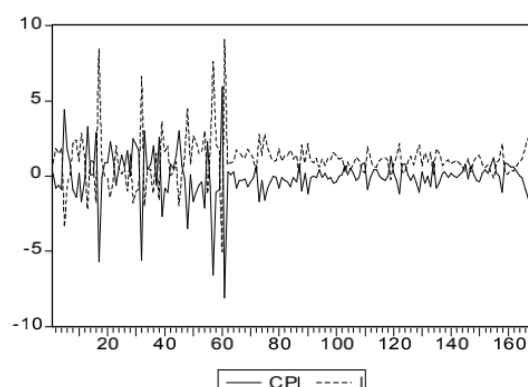


Figure 6. Curve of CPI and I

Note: CPI and I in the figure represent inflation rate and return rate respectively (unit: 1%)

-Explanation of empirical test results

The essence of stock price is determined by investors' expectation of the future overall performance or future cash flow of listed companies. Investors' expectations of the performance of listed companies are largely affected by inflation expectations. The obvious trend of inflation in a certain period of time will affect investors' expectations of the future overall economy and the performance of listed companies, and will urge investors to change their investment strategies, resulting in the overall trend of changes in stock prices and inflation, and then the stock return and inflation rate should also tend to be in the same direction. Because investors' expectations of inflation are different, the changes of inflation and stock returns will not be consistent at a certain point. That is, in the short term, inflation and stock returns will not be completely consistent, but in the medium and long term, investors will gradually digest the news and adjust their investment strategies, and the inflation expectations will generally converge, so that the stock trend will gradually coincide with the inflation trend. This spans from 5 years (by since the history of China's stock market is relatively short and the data is limited, when we do the 5-year simulation, we stack the data and get: $I = 1.941173 + 0.907685p$ T, the two are positive correlation) the conclusion can be seen from the analysis.

From the simulation results and figures, we can see that there is a negative correlation between stock return and inflation rate in a short period of time. *Jacob and Matthew(1993)*

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