Chad Nelson

ECON 450

**Testing the CAPM**

**The CAPM and Its Implications**

The Capital Asset Pricing Model (CAPM) is a financial model that is used to determine what the expected return should be for a stock based on that stock's level of riskiness. Investors expect to be compensated for risk and the price of every stock is a function of the risk-free rate and the risk premium. The risk-free rate is known but the appropriate risk premium for each stock is not always obvious. To understand what the risk premium for a given stock should be, it's useful to think about the two sources of risk each stock faces: idiosyncratic or firm-specific risk, and market risk.

Firm-specific risk is the risk that is unique to each firm and is determined by factors such as company management, the competitive landscape, and firm-specific business operations. Market risk is the risk that comes from macro variables such as interest rates, the state of the economy, and political forces. Firm-specific risk can be eliminated by increasing the number of assets in a portfolio but the market risk cannot be eliminated. Consequently, the CAPM asserts that because individuals are mean-variance optimizers[[1]](#footnote-1), they will opt for a well-diversified portfolio of stocks to eliminate firm-specific risk and therefore, the only factor that should determine the risk premium for a given stock is how sensitive that stock is to the prevailing market risk. The sensitivity to market risk for a given stock is measured by the stock’s beta. The beta of a stock is defined as the covariance between the stocks return and the market return divided by the variance of the market return . When the stock's beta is positive, the stock will perform well when the market performs well. When the beta is negative, the stock will perform well when the market is not performing well. Higher betas mean higher volatility and are therefore considered riskier stocks.

The CAPM makes sense intuitively but is it what we see in the real world? To answer that question, the CAPM can be tested empirically using data on the returns on stocks, the risk-free rate, and the market portfolio rate of return. If the CAPM holds, the only factor that should determine the risk premium for a stock is the stock’s beta, or sensitivity to market risk.

**Testing the CAPM**

To test the CAPM, I gathered monthly returns over the past 5 years (Jan 2018 - Dec 2022) of 100 quasi-randomly chosen stocks. The sample was quasi-random because many of the stocks had incomplete information during that five-year span and needed to be replaced by stocks with complete information. I also gathered the risk-free rate over that span and used the returns on the S&P 500 as the proxy market portfolio.

Testing the CAPM is a two-step process. A first pass regression is required to estimate the beta for each stock. This is done by estimating the following equation using OLS:

After the beta for each stock is estimated, a second pass regression is required to test the hypothesis that the only factor that should influence the risk premium of an asset is the beta of that stock. The second pass regression equation is presented below with being the coefficient of the stock’s beta variable and being the coefficient of the variance of the residual’s variable from our first pass regression:

If = and the CAPM holds because it would suggest that the only variable explaining the risk premium for a stock is that stocks’ beta.

Figure 1 presents a summary table of the first pass regression.

**Figure 1: First Pass Regression Summary Table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | β |  |  |  |
| **Mean** | 1.05 | 0.014025 | -0.27% | -0.41% |
| **Std. Dev** | 0.45 | 0.057573 | 1.16% | - |
| **Min** | -0.60 | 0.000224 | -4.49% | - |
| **Median** | 1.10 | 0.004130 | -0.39% | - |
| **Max** | 1.90 | 0.563429 | 5.49% | - |

The mean beta in the sample is 1.05, which means that on average, if the market portfolio goes up by 1%, the average stock will go up by 1.05%. The average difference between a stock’s return and the risk-free rate in the sample was -.27%. So, on average, investors would have been better off putting all their money in the risk-free rate over this period. This result seems a little odd but it makes sense given how poorly the market performed during this time. Figure 2 displays the relationship between the market rate of return and the risk-free rate of return during the sample period.

Given these results, if the CAPM holds true for the sample, the estimated and should equal 0, -.0041, and 0 respectively. However, the second pass regression failed to support these hypotheses. Figure 3 contains the key figures for the second pass regression.

**Figure 3: Second Pass Regression Results**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Coefficient** | **Std. Error** | **t** | **P > |t|** | **[0.025** | **0.975]** |
| **Intercept** | -0.0071 | 0.003 | -2.789 | 0.006 | -0.012 | -0.002 |
| **Stocks Beta** | 0.0029 | 0.002 | 1.278 | 0.204 | -0.002 | 0.007 |
| **Residual Variance** | 0.0974 | 0.018 | 5.490 | 0.000 | 0.062 | 0.133 |
| No. Observations: 100 | | | | | | |
| R-squared: 0.269 | | | | | | |

**Results**

The second pass regression shows the coefficients on the variance of the residuals and intercept to be statistically different from 0. An F-test that reported an F-value of 0.0027 which means that the stock’s beta coefficient is statistically different from -0.0041. These results reject the CAPM.

The positive beta coefficient suggests that higher beta stocks had higher risk premiums, which makes sense. However, the residual variance coefficient is positive, which suggests factors besides a stock's beta influence the risk premium. The residual variance coefficient is extremely statistically significant, the p-value is essentially 0.

There are several possible explanations as to why the CAPM was rejected. One weakness in this experiment is an over representation of large established firms. The average start date for a stock in the sample is 1988, which means that most of these companies have been around for a long time and are likely well established. Large firms tend to have smaller betas compared to small startup firms. This could cause an upward bias in the beta coefficient of the second pass regression because the sample may be over-representing the systematic risk in the market. If this experiment used a more representative sample, it could be that the beta coefficient would be smaller and closer to the value that the CAPM would predict.

Another possible reason the CAPM was rejected could be due to the violation of one or more of the CAPM assumptions. The CAPM relies on a list of assumptions that must be true for the results to be consistent with the theory. One of those assumptions that is almost certainly violated is that all investors have homogeneous expectations[[2]](#footnote-2). The sample period occurred during a time of great financial uncertainty due to COVID-19. The asymmetry of information during this period was likely much higher than previous periods because certain people or industries may have had more information on the progress of a vaccine. While it’s hard to quantify exactly how much asymmetry existed during this time, it’s reasonable to expect it was higher. The asymmetry of information would have increased market volatility and introduced noise into the CAPM prediction.

Another assumption of the CAPM model that was likely violated is the assumption that all investors have identical holding periods3. This is always a somewhat unrealistic assumption, but it’s even more unrealistic considering everything that transpired during the pandemic. Uninformed traders flooded the market in an effort to make money while in quarantine. These investors likely had much shorter time horizons which would influence their risk-tolerance and expected returns. Impatient investors are more likely to pay an additional premium for securities that can potentially offer quicker returns. Examples of these securities would include crypto currency. The additional willingness to pay for quick returns would show up in the residuals of the second pass regression because it is a factor that influenced the risk premiums but is unrelated to the true value of the stock. Additionally, an increase in uninformed traders would only further increase the information asymmetry in the market further violating the homogeneous expectations assumption.

**Conclusion**

The CAPM model predicts that the risk premium investors receive for a stock should only depend on how sensitive that stock is to the market risk. An empirical test on the CAPM rejected these results. However, a better experiment design and a less volatile period of analysis could potentially yield different results. Despite the CAPM’s empirical weaknesses, and unrealistic assumptions, it is still a useful model to understand asset pricing. The main idea of the CAPM is that stocks with high market risk should have higher risk premiums and therefore higher expected returns. The positive beta coefficient in the second pass regression confirms this finding, albeit without statistical significance.

1. The assumptions of the CAPM:

   **Investors are mean-variance optimizers**

   Investors have identical holding periods or common planning horizons

   Investors have homogeneous expectations

   All assets are publicly held and traded on public exchanges

   Investors can borrow or lend at a common risk-free rate

   No taxes or transaction costs [↑](#footnote-ref-1)
2. 2,3 The assumptions of the CAPM:

   Investors are mean-variance optimizers

   **Investors have identical holding periods or common planning horizons**

   **Investors have homogeneous expectations**

   All assets are publicly held and traded on public exchanges

   Investors can borrow or lend at a common risk-free rate

   No taxes or transaction costs [↑](#footnote-ref-2)