**Using CAPM to Evaluate the Performance of Listed Investment Companies with R**

*The main reason an investor would choose to invest in LIC securities is to chase the returns that are higher than that of a market benchmark (alpha returns). We analyse the performance of ASX Listed Investment Companies (LICs) over the past to determine whether such an investment is worthwhile.*

The return on an investment should compensate an investor for the time value of the capital they have invested, as well as the risk that their investment may be lost and not returned. The Capital Asset Pricing Model (CAPM) is widely used in finance as a means of determining the level of compensation an investor should expect to receive from an investment given the level of risk associated with holding that particular asset rather than holding a “risk-free” asset, such as sovereign government bonds.

*Types of risk*

**Idiosyncratic (Unsystematic) risk –** Refers to risk that is unique to that particular asset. Idiosyncratic risk can be reduced through diversification and maintaining a well-constructed portfolio [Investopedia 2019a]. <https://www.investopedia.com/terms/u/unsystematicrisk.asp>

**Systematic risk –** Refers to market-wide risk, which cannot be reduced through portfolio diversification. Although an investor can build a portfolio that limits their exposure to systematic risk, the CAPM theory suggests this will come with a trade-off of the returns they can expect to receive [Investopedia 2019b]. <https://www.investopedia.com/terms/s/systematicrisk.asp>

*CAPM and calculating the expected return of holding an asset*

Since it is possible to diversify investments in such a way as to eliminate idiosyncratic risk, returns on investments do not compensate an investor for holding this risk. Therefore it is essential that an investor diversifies their investments to avoid carrying risk that they will not be compensated for. *\*How this diversification can be done is beyond the scope of this article, however in a future article I will discuss Modern Portfolio Theory which enables the development of a portfolio of assets designed to eliminate idiosyncratic risk through asset diversification and obtain an appropriate level of exposure to systematic risk based on personal risk tolerance preferences.*

The CAPM methodology describes the relationship between the **expected return** of an asset and its exposure to **systematic risk**. To calculate the expected return of an asset given its risk, by way of CAPM, the following equation is used:

[1]

**Where:**

​ - is the return of the asset or portfolio

- is the return on a “risk-free” asset, such as government bonds

- is the “beta” of the asset. It is a measure of systematic risk exposure of an asset or portfolio

-is the return of the market or market tracking index

- is known as the “market risk premium”. It indicates the return on a market replicating portfolio on top of the return that could otherwise have been obtained from holding the “risk-free” asset.

(Investopedia 2020) <https://www.investopedia.com/terms/c/capm.asp>

By manipulating this equation, we can utilise financial asset data and regression analysis to evaluate firstly whether the CAPM theory holds up in practice and secondly to evaluate the performance of particular financial assets.

[2]

In equation [2] we have subtracted from both sides to get on the left which indicates the historical returns an investor would have received from holding a “risky” asset, in excess of the returns from holding the “risk-free” asset. We have also introduced two new variables, namely alpha, , and the regression error term, .

- represents the “alpha” return of the asset. It is a measure of the return on an investment that may be obtained through active management. Under the Efficient Markets Hypothesis, and for the CAPM to hold in practice, new information is expected to be immediately represented within the price of an asset. Therefore our hypothesis is that active management of investments should not yield alpha returns, and we expect our analysis to return a value for that is statistically indifferent from zero.

– represents the error term of our regression model. Under traditional linear regression assumptions the conditional expectation of is equal to zero.

This methodology follows from Jensen (1968) in which the performance of US mutual funds was systematically examined to determine whether any were able to “outperform the market” [[file:///C:/Users/dtunks/Downloads/Financial%20Econometrics%20Textbook%20-%20Brooks.pdf](file:///C:\Users\dtunks\Downloads\Financial%20Econometrics%20Textbook%20-%20Brooks.pdf) (pp. 67-81)].

**Using CAPM to Evaluate the Performance of LICs currently available on the ASX**

*Listed Investment Companies (LICs) -* A LIC is similar to a Managed Mutual Fund, however investors are able to buy and sell shares in a LIC just like ordinary shares on a stock exchange. As such, historical pricing data is readily available online and can be easily sourced to conduct our analysis. Generally, the aim of holding LIC securities is to gain access to the skills and expertise of the LIC managers who utilise active investment strategies to outperform a defined benchmark. For holding LIC securities, investors are charged a management fee in the range of 1.0-1.5% per annum.It is also not uncommon for LICs to charge performance fees when returns are above the defined benchmark, typically 10-20% of the return above that of the benchmark (Firstlinks 2016) <https://www.firstlinks.com.au/understanding-lic-fee-structures>.

*Passive Exchange Traded Funds (ETFs) -* Unlike the actively managed LICs, the aim of a passively managed ETF is to replicate the performance of defined benchmark, such as a market index (ASXETFS.com 2019) <https://www.asxetfs.com>. The fees an investor can expect to pay for holding a passive ETF are generally just a fraction of those charged by actively managed LICs. For example, our analysis uses the Vanguard Australian Shares Index ETF (VAS) which seeks to track the return of the S&P/ASX 300 Index before taking into account fees, which as of May 2020 are 0.1% per annum (Vanguard 2020). <https://www.vanguardinvestments.com.au/retail/ret/investments/product.html#/fundDetail/etf/portId=8205/?overview>

*Why would an investor prefer an LIC over a passive ETF?* - Using the CAPM terminology introduced above, the main reason for an investor choosing a LIC investment over a passive ETF is the belief that the active investment strategies employed by the LIC managers will yield “alpha” returns ( > 0) whilst minimising risk exposure.

*Example Analysis - Evaluating the Performance of LICs over the past 5 years*

The following sections will utilise the CAPM methodology of Jensen (1968) to examine the historical performance of Australian LICs by obtaining estimates for the and parameters of each security. Further, we will use our findings to evaluate the potential for building portfolios to replicate the returns of the LIC assets using a combination of a passive index tracking exchange traded fund (ETF), namely the Vanguard Australian Shares Index ETF (VAS), and Australian Commonwealth Government bonds.

The first order of business for our analysis is to obtain the required data. We have decided to use monthly returns data for the past 5 years as this is a common timeframe and frequency for calculating CAPM parameters, \*this is currently the timeframe and frequency used for the beta calculation on Yahoo (Au) however the analysis and code can be easily adapted to accommodate alternate timeframes and frequency. For our analysis we have used returns data from 2015-06-01 through 2020-03-01.

*LIC List -* A list of current LICs trading on the ASX was obtained from <https://www.asxlics.com/>, imported to R as a data frame and cleaned.

[INSERT CODE]

*Risk-free rate data -* Sovereign government bonds are widely used in finance as “risk-free” assets (Investopedia 2020) <https://www.investopedia.com/terms/r/riskfreeasset.asp>. For our analysis we will be using the yield data on Australian Commonwealth Government bonds with 5 years to maturity. \*The 5-year timeframe was chosen simply as it paired nicely with the 5 year timeframe selected for data collection. This data can be sourced from the [Reserve Bank of Australia](https://www.rba.gov.au/statistics/tables/#interest-rates)’s webpage. \*\*Prior to importing this data into R, we quickly formatted the dates to YYYY-MM-DD in Excel.

[INSERT CODE]

*Benchmark Index Data -* We have elected to use pricing data for the passively managed [Vanguard Australian Shares Index ETF (VAS)](https://www.vanguardinvestments.com.au/retail/ret/investments/product.html#/fundDetail/etf/portId=8205/?overview) as a proxy for the market returns. The fund seeks to track the return of the S&P/ASX 300 Index, therefore we would expect obtain comparable results if we were to explicitly use direct price data of that market index or, to a lesser extent, another index such as the All Ordinaries or S&P/ASX 200. The reason for using the Vanguard ETF data is that it will enable us to readily produce replication portfolios following our initial CAPM modelling. Historical price data for VAS was obtained from [Yahoo Finance](https://au.finance.yahoo.com/quote/VAS.AX/). We use “Adj. Close” price data as this data series is adjusted for dividend distributions and enables our analysis to consider the dividend cashflows an investor would have been entitled to, as well as the capital gains return.

[INSERT CODE]

*LIC Data -* The list of LICs was then used to obtain historical pricing data for each from [Yahoo Finance](https://au.finance.yahoo.com/). Again “Adj. Close” price data is used. Using R, the data was compiled into a single xts object along with the risk-free data and benchmark data, then trimmed.

[INSERT CODE]

*Generating the CAPM Variables -* As indicated above, the CAPM regression analysis requires us to calculate the “Excess Returns”, , for each LIC and the “Market Risk Premium”, . We calculate these into a new data frame called “capm.data” in case we wish to export and save the data.

[INSERT CODE]

*Calculating the CAPM Parameters and*

Having compiled our data, we are now ready to calculate the CAPM parameters and . To do so, we use a series of linear regressions with the “Excess Returns”, , of our LICs as our dependent variables and the “Market Risk Premium”, , as our explanatory variable. It is important to note that not all of our LICs have data for the entire 5 year period, and as such some of the parameters will be less precisely estimated given the fewer data points available. \*Again, one may prefer to adjust the timeframe and frequency to alleviate this issue. The below code calculates the parameters and , as well as using a t-test function to produce their p-values so we can have some idea of how accurately the parameters have been estimated.

[INSERT t-test function CODE]

[INSERT CODE]

For we have simply tested the hypothesis that our estimated value is indifferent from 1, that is that the LIC security tends to move in line with the market as a whole. \*This test and subsequent p-value is not overly relevant to our particular line of analysis, however the t-test can be modified to test whether is indifferent from any particular value so could be useful if we chose to drill our analysis down a bit deeper into the individual LICs and how they have historically reacted to broader market movements.

For , our hypothesis is that our estimated value is indifferent from zero, indicating that we have not found the LIC managers to be outperforming the market, or evidence to suggest the CAPM does not hold based on the data we have collected. Therefore we simply need to check whether we have obtained a positive and statistically significant value for any of the LICs.

[INSERT CODE LICs$alpha.rtns]

Our results show that over this period not a single LIC achieved a statistically significant (at the 95% confidence level), positive alpha return. In fact, there was only the one LIC to have an estimated alpha value statistically different from zero, and in that case the alpha value was -0.0051, indicating that this LIC had underperformed the market relative to the systematic risk exposure. If we widen our “significance” cut-off to the 90% confidence level, we only find one additional LICs with a significant alpha value, again it is estimated to be negative indicating underperformance. We can therefore conclude that our analysis has not found any evidence to suggest that the actively managed LICs are yielding returns for investors that are significantly greater than the returns of the broader market, relative to the risk exposure.

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**Building Replication Portfolios**

Since we have now seen that the LICs have not outperformed the market by delivering statistically significant higher returns, we are able to make portfolios combining the risk-free asset and the market tracking ETF that replicate the return of the LIC with a lower risk exposure.­ From our findings regarding alpha returns above, we know that the expected return of our replication portfolio and those of the LIC securities will not be statistically different from one-another. \*It is also worth reminding ourselves at this point that we have not accounted for any management or performance fees that may be charged by the LICs. Therefore if we can show our replication portfolios exhibit less variation in returns when compared to the relative LIC we can be confident that these portfolios deliver comparable returns to an investor for less risk expose.

*Calculating the standard deviation of the LICs and their relative replication portfolio*

We first need to calculate the standard deviation of the LIC excess returns, , using the data series produced earlier of each LIC.

- The return standard deviation is a measure of variation in the LIC excess returns series. It should not be confused with the standard error of the expected return calculated above.

[INSERT CODE]

Next we need to calculate the excess returns for our replication portfolios, , by first calculating the historical return for each period, then subtracting the risk-free rate. From this, the standard deviations of the replication portfolio excess returns, , can be calculated.

- The return standard deviation is a measure of variation in the portfolio excess returns series. It should not be confused with the standard error of the expected return calculated above.

[INSERT CODE]

Finally, we check whether the standard deviation of the returns from our replication portfolios is lower than that of the LIC securities, indicating less risk exposure.

[INSERT CODE]

The results show that for every LIC in our analysis we have been able to produce a replication portfolio, combining a passive index tracking ETF and risk-free assets that will produce a comparable rate of return while exposing an investor to less risk.

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*Conclusion*

We have shown through this analysis that over our sample period (2015-06-01 through 2020-03-01) we fail to reject our hypothesis that LIC managers were unable consistently deliver returns above those offered by holding a replication portfolio of a passive index tracking ETF and risk-free assets. Further, investors holding LIC securities are being charged a higher management fee, and in some cases a performance fee, to hold these securities with the belief that the expertise of their LIC manager will deliver the highest possible return for the lowest possible risk exposure. Yet we have seen that by holding a replication portfolio, investors will also be able to reduce their risk exposure.

*It is important to note that, as with all financial assets, past performance is not always a reliable indicator of future performance. The analysis above has used 5 years of monthly price data, using different timeframes and periods will likely yield different results.*

*I have posted this article not with the intention of providing financial advice, but to share the methodology and coding for others to replicate with their own preferences.*

Resources – Packages list