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title: 'Better Forecasting: CAPM vs ARMA'

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- Time Series

- Forecasting

- Autoregressive Moving Average

- Capital Asset Pricing Model

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The study uses Capital Asset Pricing Model (CAPM) to better predict Auto Regressive Moving Average (ARMA) models using stock return data of BlackBerry Limited and Telus Corporation. CAPM is used to find the relationship between return on stocks and return on market using the following CAPM model,

\begin{equation}

\text{R}\_i-\text{R}\_{RF} = \alpha + \beta \text{RM}\_i - \text{R}\_{RF} + \epsilon\_t

\end{equation}

where R$\_i$ denotes return of two different stocks (BB for BlackBerry Ltd and T for Telus Corporation), R$\_{RF}$ stands for Return of Risk Free stocks (in our case, Canada 30-year Bond Yield) and RM stands for Return of the Market portfolio which in our case is S\&P/TSX composite index. All returns are logarithmic returns and series are stationary. Normality of the residuals and Ljung-Box (1978) Q-statistic were used to test for misspecifications.

I use \(\alpha\) \& \(\beta\) from CAPM to forecast market returns of Balckberry and Telus market return.

\*\*CAPM\*\*

I use Ordinary Least Squares(OLS) to estimate \(\alpha\) and \(\beta\) of CAPM for BB and T stocks, where ExpectedBB= R$\_{BB}$-R$\_{RF}$ and

ExpectedM = RM$\_{BB}$ - R$\_{RF}$.

\begin{gather}

\widehat{\rm ExpectedBB} =

\underset{(0.012)}{0.0036}

+\underset{(0.19)}{1.48}\,\mbox{ExpectedM}

\notag \\

\text{(standard errors in parentheses)}\\

T = 242 \quad \bar{R}^2 = 0.19 \quad F(1,240) = 58.67 \quad \hat{\sigma} = 0.18 \notag \\

\notag

\end{gather}

From the above regression we can see a statistically significant \(\beta\) coefficient of 1.48 and statistically insignificant \(\alpha\) value of 0.0036. \(\beta\) is a measure of a stock's volatility in relation to the market which means BB stock is in theory, 48\% more volatile than the market.

\noindent

Estimation of CAPM of T stock, where ExpectedT \ = R$\_{T}$-R\_${RF}$.

\begin{gather}

\widehat{\rm ExpectedT} =

-\underset{(0.0050)}{2.67\textrm{e-5}}

+\underset{(0.082)}{1.01400}\,\mbox{ExpectedM}

\notag \\

\text{(standard errors in parentheses)} \\

T = 242 \quad \bar{R}^2 = 0.39 \quad F(1,240) = 154.58 \quad \hat{\sigma} = 0.076 \notag

\notag

\end{gather}

Telus stock also gives a statistically significant \(\beta\) coefficient of 1.041 which shows that this stock is not so volatile with respect to the market and can be taken as a less riskier stock than BlackBerry.\(\alpha\) value is insignificant in this case as well.

\*\*ARMA\*\*

I use Auto-Correlation Function (ACF), Partial Auto-Correlation Function (PACF) plots, Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) to determine order of Autoregressive Moving Average (ARMA). Figure \@ref(fig:figs1) shows forecast of Telus and BlackBery stocks using ARMA (3,2) and ARMA(3,4) respectively. Figure \@ref(fig:figs2) presents forecast of Return of the Market portfolio using ARMA(2,3)

```{r figs1, echo=FALSE,out.width="49%",fig.cap="\\label{fig:figs1}Forecasting of Telus (RT) using ARMA (3,2) and BlackBerry (RBB) using ARMA(3,4)", fig.show='hold'}

knitr::include\_graphics(c(('/about\_files/staticRT\_forecast.png'),('/about\_files/staticRBB\_forecast.png')))

```

```{r figs2, echo=FALSE,out.width="49%",fig.align='center',fig.cap="\\label{fig:figs2}Forecasting of Return of the Market portfolio using ARMA(2,3)"}

knitr::include\_graphics('/about\_files/staticRM\_forecast.png')

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\*\*Forecasting Using CAPM and 12 periods forecast values from ARMA\*\*

Let us denote FRM, FRBB and FRT as forecasted data of the market returns, stock return of BB and T respectively, where stock returns of BB and T are calculated taking into account the values of \(\beta\) from the CAPM and 12 period forecasted data of market return.

New, in sample, forecasted stock return of BB and T is FRBB=RF+1.47972\\*(FRM-RF) and FRT=RF+1.47972\\*(FRM-RF) respectively. New forecast is shown in Figure \@ref(fig:figs3).

```{r figs3, echo=FALSE,out.width="49%",fig.cap="\\label{fig:figs3}Forecasting of Telus (FRT) and BlackBerry (FRBB)", fig.show='hold'}

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```

CAPM improved the forecast for both Telus and BlackBerry stock. Significant change is seen with the Telus stock.