**Asset Pricing Models for Cryptocurrency**

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**Cryptocurrency**

A cryptocurrency a digital asset designed to work as a medium of exchange that uses cryptography to secure its transactions. Cryptocurrencies are classified as a subset of digital currencies and are also classified as a subset of alternative currencies and virtual currencies.

**Bitcoin (BTC):** Bitcoin is the first decentralized digital currency, as the system works without a central bank or single administrator. It has the highest market cap, its coins generally trade at the highest cost of all cryptocurrencies. Bitcoins are created as a reward for a process known as mining.

**Figure 1: Bitcoin Close Price and Daily Return**

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**Ethereum (ETH):** Ether is a cryptocurrency whose blockchain is generated by the Ethereum platform. Ether can be transferred between accounts and used to compensate participant mining nodes for computations performed. It doesn’t have the longevity at the top like Litecoin, but it is built on a system that other coins are built on. Most ICOs (Initial Coin Offerings) use ethereum.

**Figure 2: Ethereum Close Price and Daily Return**

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**Ripple (XRP):** Ripple was released in 2012, Ripple purports to enable secure, instantly and nearly free global financial transactions of any size with no chargebacks. Ripple tends to have a steady price due to its large supply. It has had staying power over time.

**Figure 3: Ripple Close Price and Daily Return**

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**Market Portfolio and Risk Free Asset**

A market portfolio is a theoretical bundle of investments that includes every type of asset available in the world financial market, with each asset weighted in proportion to its total presence in the market. The expected return of a market portfolio is identical to the expected return of the market as a whole.

**NASDAQ Composite (IXIC):** The NASDAQ Composite is a stock market index of the common stocks and similar securities listed on the NASDAQ stock market. Along with the Dow Jones Average and S&P 500 it is one of the three most-followed indices in US stock markets. The composition of the NASDAQ Composite is heavily weighted towards information technology companies.

**Figure 4: NASDAQ Close Price and Daily Return**

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A risk-free asset has a certain future return. Treasuries are considered to be risk-free because they are backed by the U.S. government. Because they are so safe, the return on risk-free assets is very close to the current interest rate.

**LIBOR:** The London Inter-bank Offered Rate is the average of interest rates estimated by each of the leading banks in London that it would be charged were it to borrow from other banks. It was formerly known as BBA Libor (for British Bankers' Association Libor) before the responsibility for the administration was transferred to Intercontinental Exchange. It is the primary benchmark, along with the Euribor, for short-term interest rates around the world.

**Figure 5: LIBOR Close Price and Daily Return**

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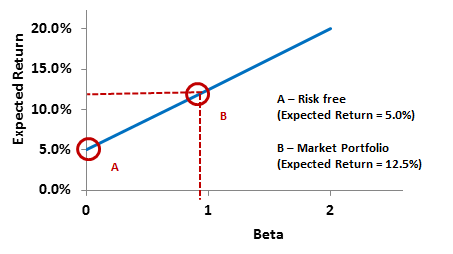
Since spikes were observed for 14-Dec-2017 (obs = 44), 15-Jun-2017 (obs = 171) and 16-Mar-2017 (obs = 234) for Daily Returns of LIBOR, these dates have been removed to avoid outlier effects.

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| **R Code to calculate exclude the spikes** | * log\_return = log(head(assets, -1) / tail(assets, -1)) * return = na.omit(log\_return[-c(44,171,234),]) |

**Capital Asset Pricing Model**

The Capital Asset Pricing Model (CAPM) gives an answer to the question asking what can be said of the market by aggregating the rational investors' decisions. The market portfolio contains all securities and the proportion of each security is its market value as a percentage of the total market value. The risk premium on the market depends on the average risk aversion of all market participants. The best-known consequence of the resulting equilibrium is a linear relationship between market risk premium and the individual security's risk:

**Figure 6: Capital Asset Pricing Model**



**Equation 1: CAPM Linear Relationship**

E(ri) − rf = βi [E(rm) – rf]

* E(ri) is the expected return of a certain security
* rf is the risk-free return
* E(rm) is the expected return of the market portfolio.

The risk in CAPM is measured by the beta βi, which is a function of the individual security's covariance with the market and the variance of the market return. Beta has numerous interpretations. On the one hand, beta shows the sensitivity of a stock's return to the return of the market portfolio and, on the other, a certain security's beta shows how much risk that security adds to the market portfolio. The CAPM states that the market gives a higher return only in cases of higher systematic risk since unsystematic risk can be diversified, so no risk premium can be paid after that:

**Equation 2: Beta Equation (Approach 1)**

βi = Covi,m / Varm

* Covi,m is the covariance between the given security's return and the market return
* Varm is the variance of the market return.

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| **R Code to calculate Beta (Approach 1)** | * cov(return$BTC - return$LIBOR, return$IXIC - return$LIBOR) / var(return$IXIC - return$LIBOR) * cov(return$ETH - return$LIBOR, return$IXIC - return$LIBOR) / var(return$IXIC - return$LIBOR) * cov(return$XRP - return$LIBOR, return$IXIC - return$LIBOR) / var(return$IXIC - return$LIBOR) |

**Table 1: Beta Estimates (Approach 1)**



We can use linear regression in order to estimate beta, where the explanatory variable is the Market Risk Premium (MRP), while the dependent variable will be the risk premium of the security. So, the regression equation has the following form, which is the formula for the Security Characteristic Line (SCL). The intercept of the characteristic line is α, the part of the stock return unexplained by the market factor. The slope of the function shows the sensitivity toward the market factor, measured by beta.

**Equation 3: Beta Equation (Approach 2)**

Ri = α + βi Rm + ei

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| **R Code to calculate Beta (Approach 2)** | * (fit <- lm((return$BTC - return$LIBOR) ~ (return$IXIC - return$LIBOR))) * (fit <- lm((return$ETH - return$LIBOR) ~ (return$IXIC - return$LIBOR))) * (fit <- lm((return$BTC - return$LIBOR) ~ (return$IXIC - return$LIBOR))) |

**Table 2: Beta Estimates (Approach 2)**



**Figure 7: Scattered Plots**

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| **Bitcoin (Beta = 1.511):**  Start Date – 22-Feb-2017  End Date – 16-Feb-2017  Y Axis – Bitcoin Returns - Rf  X Axis – NASDAQ Returns - Rf  y = 1.511x + 0.0079  R² = 0.036 |  |
| **Ethereum (Beta = 2.1209):**  Start Date – 22-Feb-2017  End Date – 16-Feb-2017  Y Axis – Ethereum Returns - Rf  X Axis – NASDAQ Returns - Rf  y = 2.1209x + 0.0146  R² = 0.0328 |  |
| **Ripple (Beta = 2.0193):**  Start Date – 22-Feb-2017  End Date – 16-Feb-2017  Y Axis – Ripple Returns - Rf  X Axis – NASDAQ Returns - Rf  y = 2.0193x + 0.0175  R² = 0.0152 |  |