Remarkable industry changes resulting from Internet technology can be seen in travel agencies (Chircu, Kauffman, and Keskey 2001), financial markets (Kaffuman, Subramani, and Wood 2000), and music sales (Bhattacharjee, Gopal, Lertwachara, and Marsden 2006), just to name a few industries. Perhaps some of the most profound changes have occurred online auctions, where Internet technology allows millions of people to transact and has become a rich source of data for many IS and statistics researchers (e.g., Kauffman and Wood 2006; Shmueli, Jank, and Bapna 2005). Technology has transformed online auctions into collectibles exchanges, where millions of similar items are bought and sold as entrepreneurs bet on resale value and look for inefficiencies. Thus, it is appropriate to apply risk and return analysis from financial research to examine the online auction exchange that has developed.

I examine 12,849 rare coin auctions involving 712 distinct rare coins collected in a 128-day period. While this dataset is extremely large, it falls short when compared to many studies in finance, as financial research often deals with millions of daily, weekly, or monthly trades over decades with hundreds of portfolios consisting of thousands of stocks. Still, we can look to finance literature for techniques that handle large datasets and examine auctions as exchanges from a financial perspective.

**Conditional CAPM Theory.** The Conditional Capital Asset Pricing Model (C-CAPM) is often used to measure risk and predict returns when risks can change. Equation (1) describes that the riskier the investment, the more return is required from risk-adverse individuals.

\[
R_t = \beta_{t-1} R_{mt} + \varepsilon_t
\] (1)

Thus, with C-CAPM, risk in the previous period (\(\beta_{t-1} = \frac{\text{cov}(R_{t-1}, R_{mt})}{\sigma^2(R_{mt})}\)) can predict returns above or below the market returns in the current period. Diversification (e.g., adding stocks to portfolios, or adding rare coins to coin collections) removes idiosyncratic risk (measured by

\[
s_t = \sigma(\varepsilon_t) = \sqrt{\sigma^2(R_t) - \beta_{t-1} \text{cov}(R_t, R_{mt})}
\]

), leaving just the non-diversifiable risk that is measured by \(\beta_{t-1}\).

**Stochastic and Empirical Models.** If the basic CAPM in Equation (1) holds true, then the estimate for the market risk premium (the slope of market return on individual returns) can be calculated by

\[
\gamma_1 = \frac{1}{T} \sum_{t=1}^{T} R_{mt}
\]

and, thus, a stochastic model can be generalized from (1):

\[
R_t = \gamma_0 + \gamma_1 \beta_{t-1} + \gamma_3 s_{t-1} + \eta_t
\] (2)

Equation (2) shows how returns should be predictable from \(\beta_{t-1}\). Thus, \(\gamma_1\) should be positively significant, while \(\gamma_0\) and \(\gamma_3\) should not be significant if diversification of risk occurs. In Equation (3), I
show how Equation (2) can be expanded into an empirical model using *multiple risk premia* from two markets: (a) the aggregated coin market returns; and (b) the S&P 500.

\[
R_i = \gamma_0 + \gamma_1 \beta_{it-1, \text{CoinMarket}} + \gamma_2 \beta_{it-1, \text{S&P 500}} + \gamma_3 s_{it-1} + \eta_i
\]  

\[
\beta_{it, \text{CoinMarket}} = \frac{\text{cov}(R_i, R_{\text{CoinMarket}, t})}{\sigma^2(R_{\text{CoinMarket}, t})} = \frac{\sigma^2(R_i) - \rho_{500, \text{CoinMarket}, t} \rho_{\text{CoinMarket}, R_i, t} \sqrt{\sigma^2(R_{\text{CoinMarket}, t})}}{\sigma^2(R_{\text{CoinMarket}, t})}
\]  

\[
\beta_{it, \text{S&P 500}} = \frac{\text{cov}(R_i, R_{\text{S&P 500}, t})}{\sigma^2(R_{\text{S&P 500}, t})} = \frac{\sigma^2(R_i) - \rho_{500, \text{CoinMarket}, t} \rho_{\text{CoinMarket}, R_i, t} \sqrt{\sigma^2(R_{\text{S&P 500}, t})}}{\sigma^2(R_{\text{S&P 500}, t})}
\]  

\[
s_i = \sqrt{\sigma^2(R_i) - \beta_{it, \text{CoinMarket}} \text{cov}(R_i, R_{\text{CoinMarket}, t}) - \beta_{it, \text{S&P 500}} \text{cov}(R_i, R_{\text{S&P 500}, t})}
\]

**GMM and Statistical Challenges.** When examining equation (3) from an OLS perspective, I find that problems exist with *serial correlation, cross-sectional correlation*, and *non-normality*. These are resolved using *generalized method of moments* (GMM) analysis. GMM, also called *two stage non-linear least squares*, is a series of simultaneous equations formed by making instrument variables of all independent variables, and then solving for the system of equations. Lately, this non-parametric technique has been used in many C-CAPM studies to adjust for any abnormalities of returns.

**Results.** I find that the C-CAPM shows that *rare coin collectors do not diversify in the short term*, either viewing the coin as part of a collection or part of a stock portfolio, but rather view each coin as a separate investment and insist on being compensated for idiosyncratic risk. I show *weak or no significance for diversifiable risk* (\( \gamma_3 \) is insignificant at *p-value* > .05). While there is some contention as to whether this is true in the long run, the fact that I show *strong significance for idiosyncratic risk* (\( \gamma_3 \) is strongly significant at *p-value* < .001) indicates that the C-CAPM model is useful in this time window. This result is opposite of stock market investments, and implies short-term profitable arbitrage opportunities in short-term speculation of collectibles sold in online auctions.

**REFERENCES**


