**TRINITY COLLEGE**

**BUSINESS SCHOOL**

**"Project 3 - Herding"**

**Module**: Financial Modelling & Analysis

**Module code**: [BU7152-202223](https://tcd.blackboard.com/webapps/blackboard/execute/announcement?method=search&viewChoice=2&editMode=false&tabAction=true&announcementId=&course_id=_76648_1&context=course&internalHandle=announcements_entry&searchSelect=)

**MSc** **Programme**: Business Analytics

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1.- Financial Market:

The financial market to be analyzed in the paper is the cryptocurrency market. In this market, assets such as $BTC, $ETH, $BNB, $CAKE, and $UNI, among others, which are digital currencies that use cryptography to secure and validate their transactions on the blockchain, are traded. This market is very interesting to analyze for many, many reasons mentioned below:

* It is a very young market, the first "successful" asset of this market could be considered $BTC and it was officially launched in January 2009, later other protocols started to appear proposing other solutions and other ways to add value to the market.
* The literature that exists related to this technology is scarce compared to the number of studies related to traditional markets (older and more established markets, such as the stock market, currencies, commodities, etc...), although lately, the number of people interested in this field has increased a lot and the information that the population has is scarce and often erroneous.
* The cryptocurrency market differs from traditional financial markets in that it is not regulated by financial institutions most of the protocols that are developed in this market are distributed or decentralized.
* The capital it moves is nothing compared to other traditional markets, the global market capitalization of cryptocurrencies is about $1T, while only that of gold is about $13T and that of the stock market total is about $90T. This, among other things, makes it a very volatile market.
* In addition, certain aspects make social networks and online forums play a very important role in defining the general sentiment and behavior of investors; The erroneous thought that it is a product devoid of value and only speculative; The accessibility it has; The volatility in the prices of cryptocurrencies; Investors are usually people close to technology and younger.
* All movements made in the blockchain are public (although pseudo-anonymous), this makes it possible to easily track operations with large amounts of capital.

All this is interesting since it makes this market especially exposed to herding, the opinions of influential people, news with relative importance, movements with large amounts of capital, etc... make other investors change their general market sentiment and this affects their investment strategies. Some examples of this phenomenon in the cryptocurrency market have been:

* Elon Musk repeatedly tweets his opinion and position on Bitcoin and cryptocurrencies, making public the number of $BTC he holds; Allowing his company Tesla to accept $BTC as a means of payment; Later retracting it because it does not use a sustainable technology; And most recently putting the $DOGE logo instead the bird icon on Twitter, etc...
* News related to the ban on cryptocurrency mining and trading in China; The conversion of $BTC into a legal tender in El Salvador; The SEC's rejection of the Bitcoin ETF; Positive or negative news about halving, etc...
* Twitter accounts dedicated to tracking the transactions and movements of the most capital-rich wallets or "whales", which depending on whether they are accumulating or selling investors shape their overall sentiment.

2.- Data:

The data source is Yahoo Finance, all the data of the assets to be analyzed will be taken from this source. The assets that have been selected as indexes, to represent the general behavior of the market, are the tokens of the most important protocols in each sector, within the cryptocurrency market, these are Top tokens with more market capitalization; Top layer 1 blockchains; Top DeFi protocols; Top CEX tokens, Top metaverse protocol tokens.

* Top tokens with the highest market capitalization: Bitcoin ($BTC), Ethereum ($ETH), and Binance coin ($BNB).
* Top blockchains of layer 1,2: Solana ($SOL) and Polkadot ($DOT)
* Top DeFi protocol tokens: Uniswap ($UNI) and Aave ($AAVE)
* Top CEX tokens: Huobi token ($HT) and OKEx ($OKB)
* Top metaverse protocol tokens: The Sandbox ($SAND) and Decentraland ($MANA)

The selected time horizon is approximately 3 years, from November 4, 2020, to May 1, 2023. The time horizon is short and this causes the analysis to lose some accuracy. This loss of information has to be assumed if more assets from different sectors are included to more accurately represent the overall market behavior.

It is important to note that giving up historical information in exchange for information about the overall market has been done with two very specific aspects of the analysis in mind:

* Many of the most important protocols today in the cryptocurrency market are less than 5 years old and to facilitate the analysis the number of observations for all assets has been forced to be identical.
* While having longer time series data can be valuable in certain types of analysis, such as trend analysis, it may not be as important when analyzing herding in financial markets. In this case, having a broader set of assets to analyze can provide a more complete picture of investor behavior and help identify patterns of herding behavior that might not be evident if only a limited set of assets were used.

The time frequency is daily, i.e., the prices and returns of these assets will be analyzed daily.

It has not been necessary to deal with missing values as there were none in any of the three assets analyzed.

La frecuencia temporal es diaria, es decir, los precios y rendimientos de estos activos se analizarán diariamente.

No ha sido necesario tratar con valores perdidos ya que no había ninguno en ninguno de los tres activos analizados.

3.- Estimating/measuring herding:

In financial markets, herding behavior refers to the tendency of investors to mimic the behaviors of other investors rather than make judgments based on their independent research. This conduct can create a self-perpetuating loop in which investors all move in the same direction, causing prices to fluctuate exaggeratedly, resulting in market volatility and instability.

The influence of herding on financial markets can be especially substantial in the cryptocurrency market, where the lack of governmental control and transparency can create an atmosphere conducive to herding behavior. In such a market, when transaction volume is minimal, a small number of major investors can influence price direction, causing dramatic price fluctuations and raising the likelihood of market collapses.

To estimate the level of herding in the cryptocurrency market, four different methods have been used:

* The first method was building a linear model between the CSAD (cross-sectional absolute deviation) and Rm (market return), Rm^2 (market return squared). This approach helps to identify whether there is a relationship between market conditions and the level of herding behavior.   
  The results of this method are:

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After building the linear regression model to determine the type of relationship between CSAD and Rm/Rm^2, a significance test of the coefficients was performed to correct for possible problems in the model related to heteroscedasticity or autocorrelation in the residuals.

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Based on the results of the linear regression model, there is a statistically significant linear relationship between the CSAD and the market return. Although these results theoretically deny the presence of herding in the cryptocurrency market, further tests will be carried out with different methods to verify this information.

Also, the significant nonlinear effect of Rm^2 on CSAD may indicate that there are other factors influencing investor behavior at higher levels of market returns.

* The second method was the estimation of a TV (time-varying) linear regression. This approach allows for the modeling of changes in herding behavior over time, which can be useful for identifying whether herding behavior is more prevalent during certain market conditions or periods.

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Based on the results of this method the lack of consistency in the coefficient can be appreciated. This lack of consistency in coefficients over time can indicate dynamic changes in the relationship between market returns and herding behavior. It could be influenced by various factors such as market conditions, investor sentiment, regulatory changes, or other external events.

* The third method was the Markov regime-switching model. This approach models changes in the level of herding behavior based on market regimes, where different regimes have different probabilities of herding behavior occurring. This approach can be useful for identifying the different factors that may be driving changes in herding behavior over time.

To build this model, the number of states had to be selected beforehand. Four different models were created with the number of states from 2 to 5. The model with 2 states was selected because it was the model with the lowest AIC and BIC. The results of this model are as follows:

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Based on the results of this model:

In Regime 1, the coefficient estimate for Rm is -0.0123 and for Rm^2 is 2.0338, Rm have different sign compared to the linear regression model, however, the coefficient is not statistically significant (p = 0.4533), suggesting that it may not have a meaningful impact on CSAD within Regime 1. The coefficient for Rm^2 has the same sign as the linear regression model and is statistically significant (p < 0.001).

In Regime 2, the coefficient estimate for Rm is 0.0575, and for Rm^2 is 2.1332. Both have the same signs as in the linear regression model. The coefficient for Rm is not statistically significant, as in Regime 1 (p = 0.522), while the coefficient for x2 is statistically significant (p < 0.001).

These results suggest that the statistical significance of Rm that was seen in test 1, when the linear regression model was constructed, is not consistent when analyzing the market in two different states, while the statistical significance of Rm^2 is.

* Finally, the last method was the quantile regression, to model the relationship between market returns and herding behavior across different quantiles of the return distribution. This approach can be useful for identifying whether herding behavior is more prevalent during extreme market conditions, or whether it is a more persistent phenomenon across different levels of market returns.

Again, to build the model first the number of quantiles had to be selected beforehand. The quantiles were selected from 10% of the distribution to 90% in intervals of 10%. And the results are as follows:

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Based on the results of this test, the inconsistency in coefficients across quantiles suggests that there may not be clear evidence of herding in the cryptocurrency financial market. Herding behavior typically involves a consistent pattern of investors following each other's actions, leading to a more uniform relationship between variables across different percentiles of the conditional distribution. The varying coefficients in the quantile regression results suggest that other factors or dynamics may be influencing the relationship between CSAD and the independent variables, rather than a uniform herding behavior.

Based on the overall findings, it can be concluded that there is limited evidence to support the existence of herding behavior in the cryptocurrency financial market. The results of the different methods applied before indicate either the absence of herding or inconsistent relationships between the CSAD and the Rm, in regimes, in quantiles, or along all the observations of the dataset.