# Betasmartz Research – Confidential - Investment Cycle Labeling Algorithm

## Objective

The intention of this document is to introduce and outline all the steps that are involved in determination of the investment cycle labeling algorithm.

This algorithm creates the labels of the time; the algorithm is monthly based due to the nature of the data.

## Data Needed

There is no particular data needed if the algorithm wants to be run at random time series. It is recommended to input macro economical time series data, as the final output will be an economic cycle the cycling pattern determination should be made from an economical perspective.

## Step 1 – Input data and data cleansing

The economic data normally comes with noise so a proper data cleansing process should be in place. This involves:

* Removing the empty dates.
* Make sure the appropriate date indexing is in place: Date format.

## Step 2 – Data transformation if needed

There are certain transformations that due to statistical reasons (normality and homoscedasticity) could have the statistical properties that are more in correlation with the variable that wants to be explained.

## Step 3 – Decile ranking sub-Algorithm

The investment cycle labeling algorithm gets its base explanatory power in a decile ranking time series factoring. The factoring consists in a cumulative percentile ranking window

### Sub step 1 – Percentile ranking calculation

A percentile ranking calculation is defined as:

Where and x is the rank of the observation.

### Sub step 2 – Window definition

The intention of the percentile ranking calculation is to provide a distribution of stable percentile ranks through time, in order for a distribution to be stable over time (and a percentile distribution particularly) it has to have enough data to be considered robust.

A first burnout period of accumulation of data is defined as 7 years. This is period is defined due to the nature of the empirically research facts of the economic cycles (the normal average period of the economic cycle is 7 years).

### Sub step 3 – Accumulation ranking

The final step is to begin the rolling window of accumulation on the percentile ranking calculation to have a percentile ranking on each observation.

## Step 4 – Trend-extraction smoothing sub-algorithm

The decile ranking algorithm delivers a discrete time series with a lot of jumps, due to the nature of this time series, for the information to be trustworthy a filtering trending algorithm has to be implemented.

There is a theoretical result that is pretty useful; basically the Theorem states that every time series could be divided in a deterministic and a non-deterministic component.

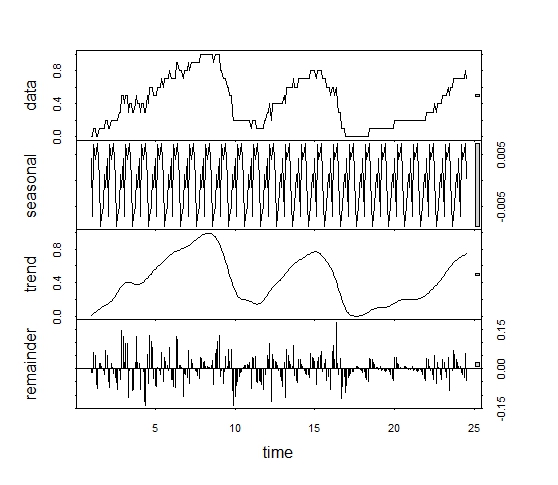
The theorem could be resumed in the following equation:

Where:

The algorithm being used is the one presented by Robert Cleveland, William Cleveland, Jean McRae and Irma Terpenning in the Journal of Official Statistics in 1990.

The trend component will be smooth and have been filtered the seasonality and white noise from the series.

An example of the decomposition is:



The trend component is the one that is going to be extract and taken as the cyclical time series to model. As it could be seen is smooth and de-noised.

## Step 5 – Critical Turning points – Sub-Algorithm