Trend characterisation of agri-food time series using Local Hurst exponent

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In agriculture, the sales of an horticultural product is essential for the supply chain. Depending on the commodity under study one should have into consideration certain variables. On the one hand, the volume of good, which is translated into offer in the market, will depend on the climate during the season, the crop extension, etc. On the other hand, demand will depend on consumption trends, availability of other products, period of the year (there are festivities or times along the year where certain products are more demanded). As a consequence, the analysis of price for such products is complicated, and in order to obtain more accurate predictions technical analysis should be accompanied by fundamental analysis (study of market trends, breaking news, weather history). While deep and complete analysis may require more data resources and experts in the agriculture sector, one can tackle the challenge using different methods regarding analytical techniques. Sometimes by observing the data history we can already notice patterns and cycles. Thus, knowing in advance the trend of a commodity will asses the farmer about the time to harvest.

In order to assist on harvest planning, forecasting the trend of a price commodity may result of great support. As a consequence, farmers can decide wether to collect the product or wait some days. In this scenario, time left for price median regression may be relevant.

Many studies have focused on forecasting price using various techniques with good accuracy, from ARIMA models to Neuronal Networks.

In our work, we study the relationship between the *Local Hurst* parameter (H) and the time needed for the time series to regress to the local median. Hurst exponent ranges between 0 and 1 providing information about the persistence of a series: when $H < 0.5$ the series is antipersistent, when $H = 0.5$ the series follows a random process, and when $H > 0.5$ the series is persistent. For our study we followed the methodology presented in [1] using the definition of Hurst from [2]. Then, for a time series $y : y_0, \ldots, y_N$ and for the time window τ Hurst parameter is computed as:

$$K(\tau) \propto \tau^H \quad \text{where,} \tag{1}$$

$$K(\tau) = \frac{< |y(t+\tau) - y(t)| >}{< |y(t)| >}, \tag{2}$$

Once we set a time window τ_H and assign a Hurst value for every time step i-th, we categorise days into three regimes: antipersistent when $H \in [0, 0.45]$, intermediate when $H \in (0.45, 0.55)$ and persistent $H \in [0.55, 1]$. Afterwards, for each i-th day we compute the local median of past τ_m days, $m_{\tau_m} = \text{median}(y_{i-\tau_m}, \ldots, y_i)$, and measure the time distance until the time series crosses the local median. Our time series describe daily price evolution of few horticultural commodities from the region of Almería (Spain) over 5-year period, from 2014 to 2019. They fluctuate from few cents to few euros.

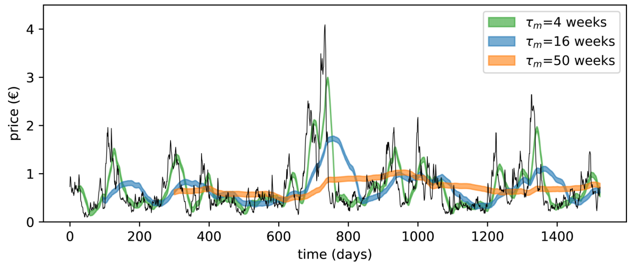

Fig. 1. Price evolution for aubergine from 2015 to 2019. Moving medians of different time windows are also represent.

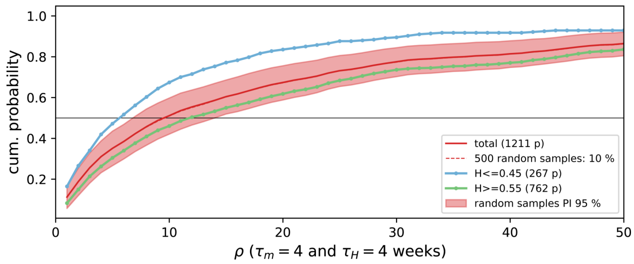

Fig. 2. Cumulative probability distribution of time for regression to local median.

Finally, we compute the cumulative distribution of time distance for next regression for the different Hurst regimes.

In Fig. 2 we have plotted the cumulative distribution of time until next regression for all days belonging to antipersistent, intermediate and persistent regime. In order to compare with a null set of data, we have also plotted the distribution of random selected sets of days from our collection. We see how persistent days (green curve) tend to regress to local median slower than rest of days. Curves suggest that for certain time scales there are significant differences between the expected time need to regress to the local median among the Hurst regimes.

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[2] T. Di Matteo, T. Aste, and M. M. Dacorogna; 'Long term memories of developed and emerging markets: using the scaling analysis to characterize their stage of development', *Journal of Banking and Finance* 29, 827-851 (2005).