

The Financial Bubble Experiment

First Results (2 November 2009 - 1 May 2010)

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On 2 November 2009, the Financial Bubble Experiment was launched within the Financial Crisis Observatory (FCO) at ETH Zurich (<http://www.er.ethz.ch/fco/>). In that initial report, we diagnosed and announced three bubbles on three different assets (IBOVESPA Brazil Index, a Merrill Lynch corporate index, gold spot price). In the subsequent release of 23 December 2009 in the ongoing experiment, we added a diagnostic of a new bubble developing on a fourth asset (cotton futures). This present report presents the four initial forecasts and analyses how they fared. We find that IBOVESPA and gold showed clear signs of changing from a bubble regime to a new one within our forecast quantile windows; that the Merrill Lynch bond index changed from a strong bubble regime to one of more moderate growth just before our publication date; and that cotton was and still is in a bubble without showing a clear change of regime.

I. INTRODUCTION

The Financial Bubble Experiment (FBE) aims at testing the following two hypotheses:

- **Hypothesis H1:** Financial (and other) bubbles can be diagnosed in real-time before they end.
- **Hypothesis H2:** The termination of financial (and other) bubbles can be bracketed using probabilistic forecasts, with a reliability better than chance (which remains to be quantified).

In [1], we described the methodology of the FBE, the background and underlying theory as well as the practical procedure. Three forecasts summarized in three .pdf documents were documented in the first release of the document on 2 Nov. 2009. A second version was released on 6 Nov. 2009 adding the SHA-2 256 and 512 checksums to the initial MD5 check sums for each of the three documents to address the concern about the vulnerability of the MD5 algorithm. A fourth forecast was added in the third version of the document on 23 Dec. 2009. Refer to Table V.

Our ambition in this first report is to diagnose bubbles in the time frame of our experiment: we aim at diagnosing and forecasting bubbles in various major asset classes which have the potential to end within a window of about 6 months or less (which is the duration between each successive release of the FBE). Because in a population of bubbles of various amplitudes, the moderate sized ones will be much more numerous than the great ones, the moderate sized bubbles are likely to be represented more often in our sample population. We provide evidence of clear corrections and *changes of regimes* instead of reports of crashes of very major amplitudes.

Ideally, we would like to aim at diagnosing in advance and predicting the turning point of major bubbles, which have the potential for devastating crashes. Examples of such bubbles include those that ended in the Oct. 1987, March-April 2000 and 2007-2008 crashes. Such events are relatively rare, typically recurring once or twice per decade at most. It would be unrealistic to specifically aim at such rare events in our experiment, because the time scale needed to reach any reliable statistical conclusion would be too long in relation to, say, an academic career. As we continue this experiment, we will almost certainly encounter such monsters.

II. LINK TO FORECAST DOCUMENTS

The original .pdf documents can be found via links at the FCO web page at <http://www.er.ethz.ch/fco/>.

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III. EXECUTIVE SUMMARY OF THE RESULTS

The four assets (and their datasources) that we identified are:

- IBOVESPA Index, Brazil (Yahoo: ^BVSP)
- Merrill Lynch EMU (European Monetary Union) Corporates Non-Financial Index (Bloomberg: EN00)
- Gold spot price in USD/oz (Bloomberg: GOLDS Comdty)
- Cotton future in USD/pound (Bloomberg: CT1 COMB Comdty)

We summarize the quantitative results in the following sections. A complete visual representation is available in the figures in Section X.

H1: Identification of a bubble

1. We support H1 by confirming that bubbles existed in two of the four assets at the time of our forecasts ($t_2 = 2$ Nov. 2009 release for IBOVESPA and gold). Our more recently developed ‘bubble index’ (Section IX) confirms that IBOVESPA is out of its previous bubble regime, thus confirming the existence of the announced changed of regime.
2. We also confirm that a bubble in the Merrill Lynch Index did exist, but it ended just before our forecast date. This is clear in retrospect with the insight of the 6 additional months of data. Our more recently developed ‘bubble index’ (Section IX) confirms that the Merrill Lynch index was just exiting a bubble at our forecast time. Thus, it is now firmly out of a bubble regime.
3. For cotton (23 Dec. 2009 release), the metrics given in section VIII give ambiguous signals concerning a change of regime. Our more recently developed ‘bubble index’ (Section IX) diagnoses that the bubble is still continuing. We cannot therefore conclude yet on the validity of our diagnostic as we have to wait on its subsequent development.

Sections V-VIII present standard measures of regime shifts performed with the benefit of the full price time series through the end of April.

H2: Forecast of change of regime

1. IBOVESPA and gold support H2 by clearly exhibiting changes of regime beginning within our forecasted quantile windows.
2. It is clear now that the change of regime in the Merrill Lynch Index started just before our forecast date. We note that the early limit for both of our quantile windows for this asset included dates before we made the forecast. That is, our analysis indicated that it was possible that the change had already begun, though that only becomes clear with the trends seen in the full time series.
3. For cotton, the quantile range predicted correctly the 12% drawdown occurring right its middle. This is however a partial success (or failure) for H2, since our present indicators diagnose that the bubble has not ended, suggesting that we previously identified a “baby” bubble (with a significant accident) that is still growing into a larger bubble.

Brazil IBOVESPA (fbe_001.pdf): Change of regime began within our forecast window: large drawdown of 11% in 30 days occurred approximately two weeks after the end of our largest forecast window. Peak and subsequent decline of fraction of positive return days and sharp drop in local growth rate of price occurred within forecast window.

	Start	End
05/95	2009-10-19	2009-12-17
20/80	2009-10-27	2009-11-29

TABLE I: Published forecast quantile ranges for IBOVESPA.

Merrill Lynch bond index (fbe_002.pdf): Change of regime began 1-2 months before our publication date: price trend changed from sharp rise (20% per year) over almost one year (Nov. 2008 - Sept. 2009) to a more moderate rise (9.1% per year). Fraction of positive return days and local growth rate confirm the change began just before our forecast date.

	Start	End
05/95	2009-10-11	2010-02-09
20/80	2009-10-27	2010-01-16

TABLE II: Published forecast quantile ranges for Merrill Lynch bond index.

Gold spot price (fbe_003.pdf): Change of regime began well within our 20-80% forecast window: large draw-down of 13% in 68 days (which includes an initial drop of 11% in 20 days). Positive return days and local growth rate confirm the timing of this transition.

	Start	End
05/95	2009-10-13	2010-09-07
20/80	2009-11-05	2010-02-25

TABLE III: Published forecast quantile ranges for gold spot price.

Cotton futures (fbe_004.pdf): Drawdown of 12% in 32 days began within our forecast window, though, it is comparable to other drawdowns in the previous year. This drawdown was followed by a steep run-up that has now plateaued. Fraction of positive return days suggest a change of regime but local growth rate analysis is inconclusive.

	Start	End
05/95	2009-12-05	2010-04-09
20/80	2009-12-31	2010-03-16

TABLE IV: Published forecast quantile ranges for cotton futures.

IV. ANALYSIS OF THE FOUR ASSETS

In the following subsections, we include figures for each asset class. The figures share some common features, explained here. Details for each individual asset and measure are discussed below.

Axes and observations: Price (or value of the asset) is shown on the left vertical axis and calendar days are indicated on the bottom horizontal axis. The blue circles represent closing price observations on trading days. Note that the price axis shows observations in their natural units on a logarithmic scale. Data for IBOVESPA was obtained from Yahoo financial for symbol ‘~BVSP’ (using adjusted close) and data for the other three assets (Merrill Lynch bond index, gold spot price and cotton future) were obtained from Bloomberg.

Large shaded region and vertical black line: The large grey shaded regions that begin near the left price axis and end at the solid black vertical line near the right vertical axis represent the domain of the observations used in our analysis. The vertical line itself sits at t_2 : the last observation used in the analysis.

Small shaded regions: Two colored shaded regions begin in the vicinity of t_2 . They represent our forecast “danger” zones, where changes of regimes are most likely to occur. The inner, narrow, green one with horizontal hatching represents the 20-80% quantile interval and the outer, wider orange (without hatching) represents the 5-95% quantile interval. That is, these two numbers imply a 60% (respectively, 90%) probability for the end of the bubble to be located within the green (respectively, orange) zone.

Zoomed figures: Some figures below show a zoomed-in version of a main figure, where the vertical line at t_2 is centered.

Drawdown analysis: Drawdown analysis figures show a solid red line connecting the path of the largest drawdown observed between t_2 and the most recent observations used in this document (27 April 2010). The percentage drop and duration of this drawdown is indicated in text in the lower right corner of each figure. A drawdown is simply defined as the largest peak-to-trough drop in price in a given region.

Fraction of up days in a running window: We calculate one day close-to-close returns for each asset and mark them as positive (up) or non-positive (zero or down). The ratio of up days relative to the sum of up and down days in a running window of 30, 60 or 90 days is plotted on top of the price observations. The right vertical axis shows this fraction on a logarithmic scale. Note that we do not include returns with a value of zero in the calculation of this ratio. Also, the running window *ends* at the value plotted on the time axis. That is, only present and past data is used in the running window, not future data.

Derivative of observations: Another measure of the change of regime is provided by an estimation of the local growth rate. We use the Savitzky-Golay smoothing algorithm to calculate the first derivative of the observations, using a third order polynomial fit centered within windows of 120 and 180 days. The scale of the estimated derivative is shown on the right vertical axis using linear scaling.

V. ANALYSIS OF THE BRAZIL INDEX (IBOVESPA)

Figure 1 summarizes the evolution of the Brazil index (IBOVESPA) over the period of interest. Figure 2 provides a zoomed view of the same information. Visual inspection suggests that indeed there has been a change of regime, coincident to the danger zones delineated in the two shaded quantile regions. Here the change of regime corresponds to a transition from a fast ascending price to a noisy plateau without growth.

The existence of the change of regime occurring roughly in the danger zones is made perhaps more quantitative by Figure 3 showing the fraction of days with positive returns (close-minus-close) in a moving window of 90 days. One can observe that this fraction was continuously increasing over the interval represented in grey over which we identified a bubble, culminating at the value of 65% exactly in the middle of the 5-95% danger zone. This peak was followed by a steep decline back to a no-trend value of close to 50%.

Figure 4 shows that the two estimations of the local growth rate plunged to close to zero just in the danger zones, confirming the visual impression of a change of regime.

VI. ANALYSIS OF THE MERRILL CORP. NON-FINANCIAL INDEX

Figure 5 summarizes the evolution of the Merrill Lynch EMU (European Monetary Union) Corporates Non-Financial Index over the periods of interest. There has been a change of regime, in the sense that the growth rate has rather brutally changed in August-September 2009, as indicated by the two trends shown as the two straight lines. The leftmost, steeper trend line has a slope equivalent to an annualized return of 20% while that of the rightmost, flatter trend line is 9.1%. But, of course, such a change in trend is only clear in retrospect when sufficient data has been accumulated to confirm it. The change was not clear at the time when our forecast was performed. Our method has identified this change of trend occurring after a strong growth regime as the signal of a more dramatic bubble end.

Figure 6 shows the fraction of days with positive returns (close-minus-close) in a moving window of 90 days. One can observe that this fraction has been continuously high, oscillating around 70% for most of 2009, until it started to descend below 60% over the time interval indicated by the danger zones.

Figure 7 shows that the estimations of the local growth rate of the Merrill Index in two moving windows (60 and 90 days) plunged to close to zero slightly before the danger zones, confirming the visual impression of the change of growth regime.

VII. ANALYSIS OF GOLD

Figures 8 and 9 summarize the evolution of the gold spot price over the period of interest. Visual inspection suggests that indeed there has been a change of regime, coincident with the danger zones delineated in the two quantile windows. Here the change of regime corresponds to the transition from a fast ascending price to a significant drawdown followed by a noisy plateau without growth. Note that the drawdown of 13% in 68 days includes an initial steep drawdown of 11% in 20 days.

Figure 10 shows the fraction of days with positive returns (close-minus-close) in a moving window of 90 days. One can observe that this fraction was increasing steadily since the end of 2008, peaking at a value of 64% exactly in the middle of the 20-80% danger zone. This peak was followed by a steep decline back to a no-trend value of close to 50%.

The Savitzky-Golay smoothed local estimations of the growth rate of the Gold spot price in 60 and 90 day moving windows show drops into negative values just in the danger zones, confirming the visual impression of a change of regime.

VIII. ANALYSIS OF COTTON FUTURE PRICE IN USD

Figure 12 summarizes the evolution of the cotton future price in USD over the periods of interest. It is not clear that there has been a change of regime. One can see a drawdown outlined in red with a cumulative loss of 12% in 32 days, but it is followed by a strong rebound, almost recovering the previous trend. Visual inspection may be misleading and we resort to the previous usual metrics.

Figure 13 shows the fraction of days with positive returns (close-minus-close) in a moving window of 90 days. One can observe that this fraction has been increasing steadily and then plateaued over the interval indicated by the grey zone over which we diagnosed a bubble, culminating at a value of almost 65% in the first tier part of the 20-80% and 5-95% danger zones. This peak was followed by a clear decline developing over the danger zones.

Figure 14 shows an estimate of the local growth rate using the same parameters as for the three other cases. This metric shows no change of regime.

IX. WHAT WOULD WE DO DIFFERENTLY NOW?

Since the first incarnation of the FBE implemented in the first version of this document [1], monitoring the development of the forecast in real time has been quite a learning experience. Several improvements have been developed which will be incorporated into the next set of forecasts. Here, we provide just a flavor by showing a new metric and the impact it would have had on these four forecasts.

The metric is a “bubble index”, which quantifies the probability for a bubble to be present and is shown for each asset in Figures 15- 18. This metric mainly aims at hypothesis H1, the diagnosis that a bubble is present. As can be seen in Figure 16, we would not have chosen the forecast for Merrill Corp. Non-Financial Index because the bubble index was telling us loudly and clearly that the bubble had formed well in advance of our publication date and had already ended when we made our forecast. This new bubble index supports our previous analysis above of diagnosing bubbles in IBOVESPA and gold, with high values of the index leading up to and into the quantile regions. Also, this metric and others show a clear signal for cotton, supporting our claim that this asset is still in a bubble regime.

Publication date	MD5SUM
Document name	SHA256SUM
Asset	SHA512SUM
2009-11-02 fbe_001.pdf IBOVESPA (Brazil)	6d9479eb2849115a12c219cfa902990e d7ad5c9531166917ba97f871fb61bd1f6290b4b4ce54e3ba0c26b42e2661dc06 808bbfaddbca3db8d0f55d74cabedf5201ecd70340f86e27dfac589ce682144f52f6fc4b3ff1ac75231038d86dae58bd320e7fb17ef321b4bc61a19e88071039
2009-11-02 fbe_002.pdf ML Corp. Non-Fin. Index	5d375b742a9955d4aeea1bd5c7220b2b 5a9c395b9ab1d2014729ac5ff3bb22a352e14096fa43c59836ea0d4ae0e3b453 e7ef9150b4738253f4021b0600eff1cd455b2671e421b788b9268b518439b56699994b3f8b395742bdc7622b5536034e74ade86e0a46bfff1ed5ff9a293f809f
2009-11-02 fbe_003.pdf Gold spot price (USD)	fd85000d0ce3231892ef1257d2f7ab1e d3f3d504d85d50eb3dc0fe2c3042746db2f010509f4d1717370d14012972e86f 91a8fa82b7f08deea2df2a1f7cef266f5aa155bb0c047f65b14315f7229d92976cc7b30453453fb8ecd0350783907c83652192d32ba90fb1cce128385832e63a
2009-12-23 fbe_004.pdf Cotton futures (USD)	8e019304004ebf06df17384ff664ff57 27c650d85a802eafecd8389391c440458816ff13b5c573bab710e3b7739f2e38 388fa7941c691fe7c8887886a932dd6a6aa28a967b5b05bf3cf96cdb836b499f354a78bca67d86aa246985b80e75670c3bd6300ff6f4f92ca3bd0b59ac675e1eb

TABLE V: Checksums of Financial Bubble Experiment forecast documents. The documents fbe_001.pdf to fbe_003.pdf contain the diagnostics of 3 different bubbles in 3 distinct assets, and were finalized on 2 Nov. 2009. The document fbe_004.pdf contains the diagnostic of an additional bubble of another asset, which was finalized on 23 Dec. 2009. This table was released on 2 Nov. 2009 and updated on 23 Dec. 2009 in the document [1]. Here, we add the name of the asset corresponding to each document.

X. FIGURES

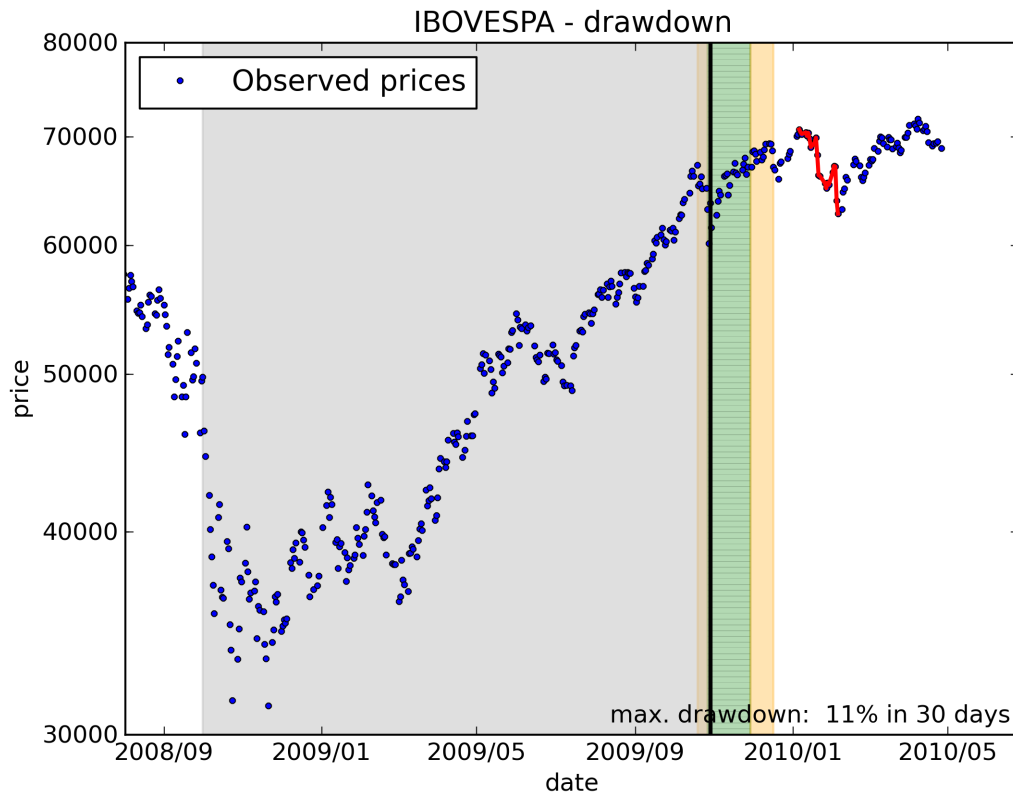


FIG. 1: Time series of the Brazil Index (IBOVESPA) shown as filled blue circles, the 20-80% (respectively 5-95%) quantile intervals for the predicted end of the bubble and the subsequent evolution of the index. The black vertical line shows the time of the last observation used in the analysis. The red solid trace shows the largest drawdown that occurred after the forecast, 11% in 30 days.

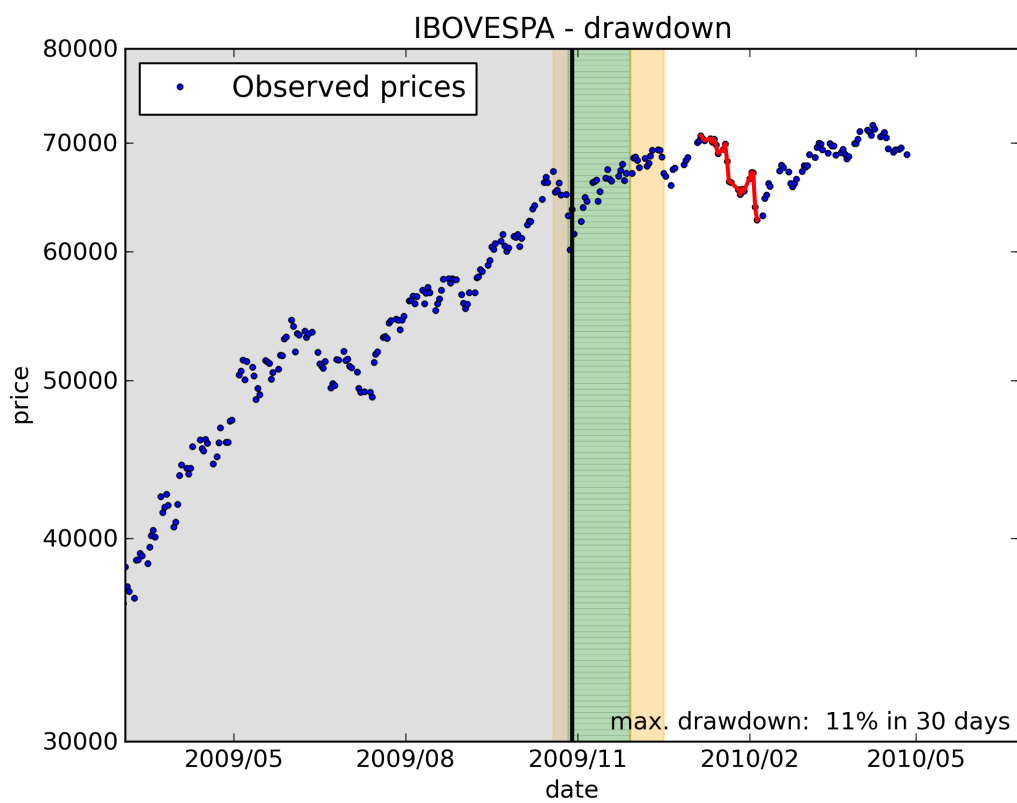


FIG. 2: Zoom of Figure 1.

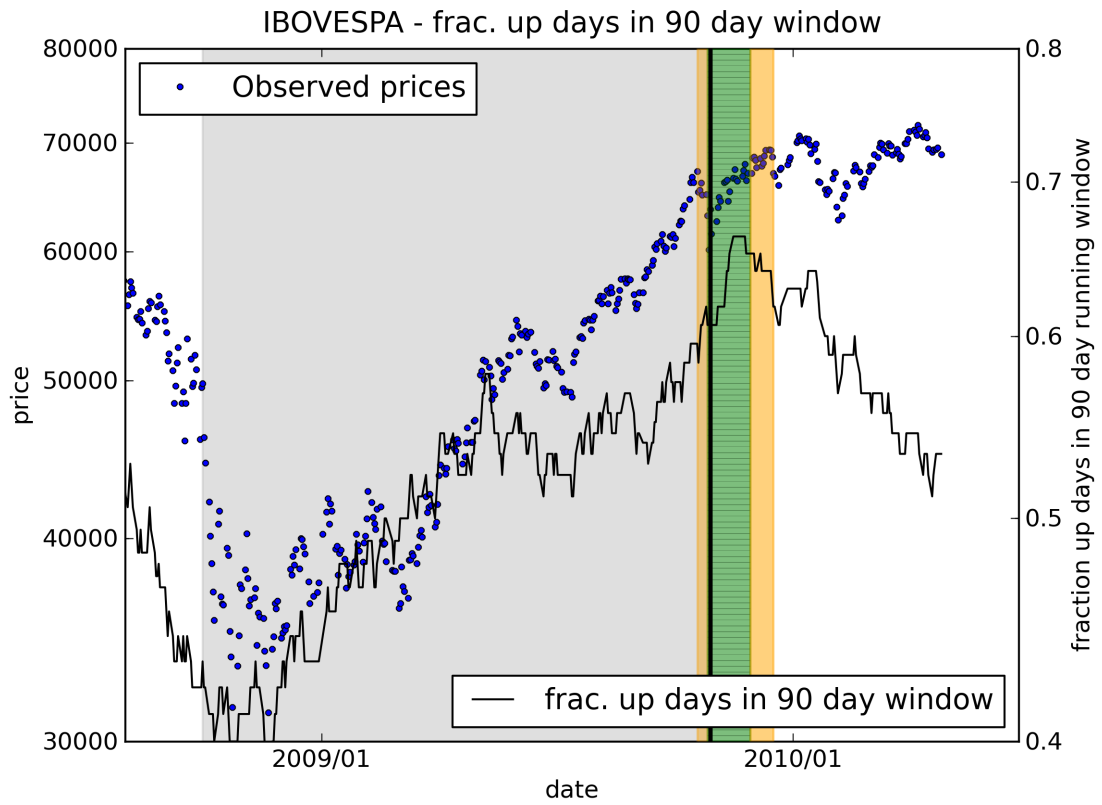


FIG. 3: On the data shown in Figure 1, we plot the fraction of days (right vertical scale) with positive returns as a function of the right-end time of a moving window of width equal to 90 days.

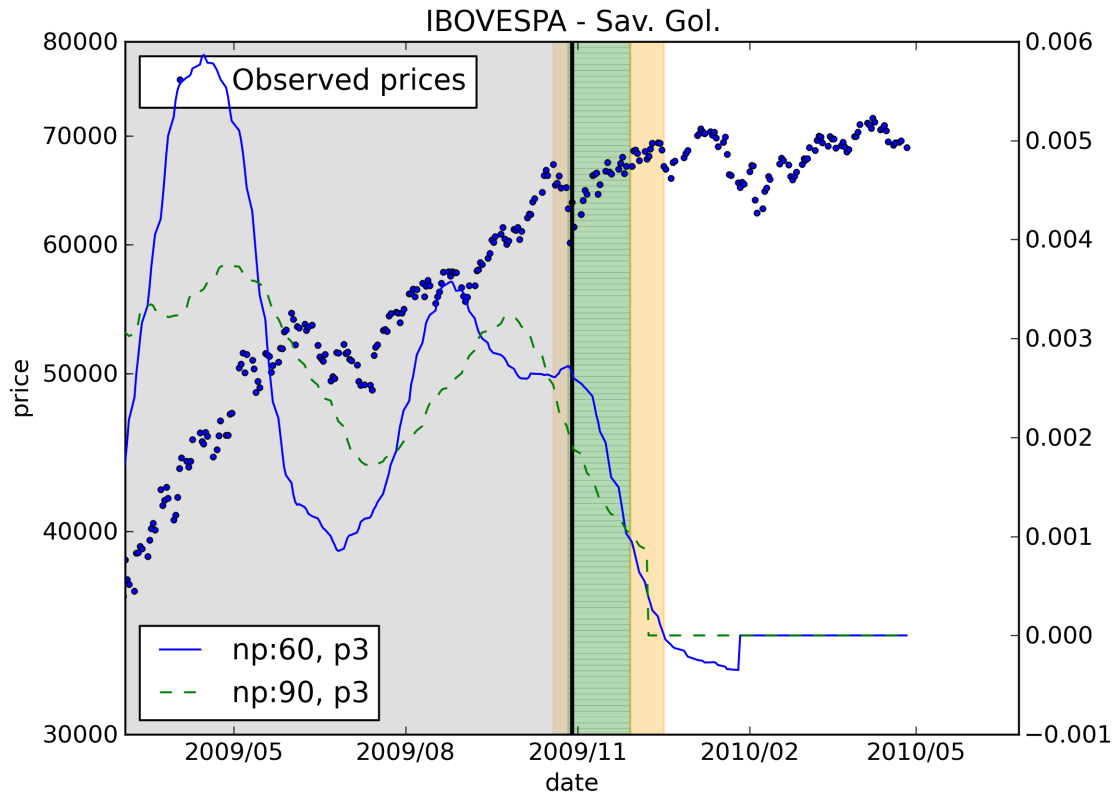


FIG. 4: On the data shown in Figure 1, the dashed green line (respectively continuous blue line) gives the smoothed growth rate of the Brazil index in the middle of a running window of 180 (respectively 120 days), as estimated with the Savitzky-Golay smoothing algorithm with a polynomial of order 3.

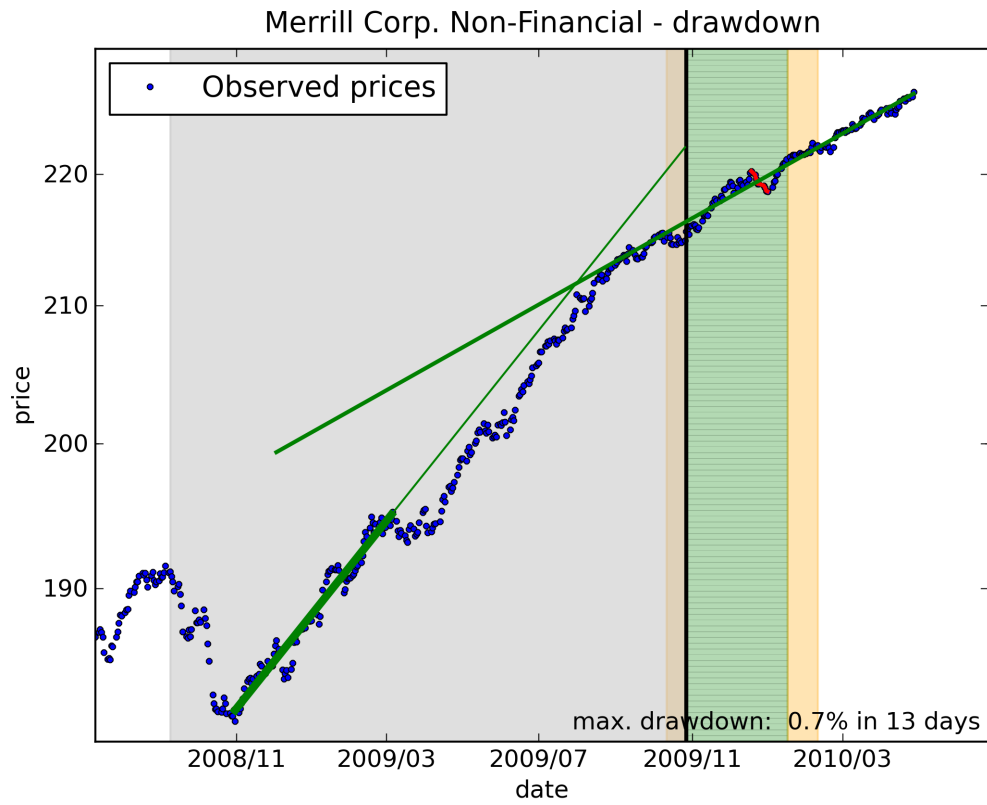


FIG. 5: Time series of the Merrill Lynch EMU (European Monetary Union) Corporates Non-Financial Index (Total Return Index, EN00) shown as filled blue circles, the 20-80% (respectively 5-95%) quantile intervals for the predicted end of the bubble and the subsequent evolution of the index. The black vertical line shows the time of the last observation used in the analysis. The red solid trace shows the largest drawdown that occurred after the forecast, 0.7% in 13 days.

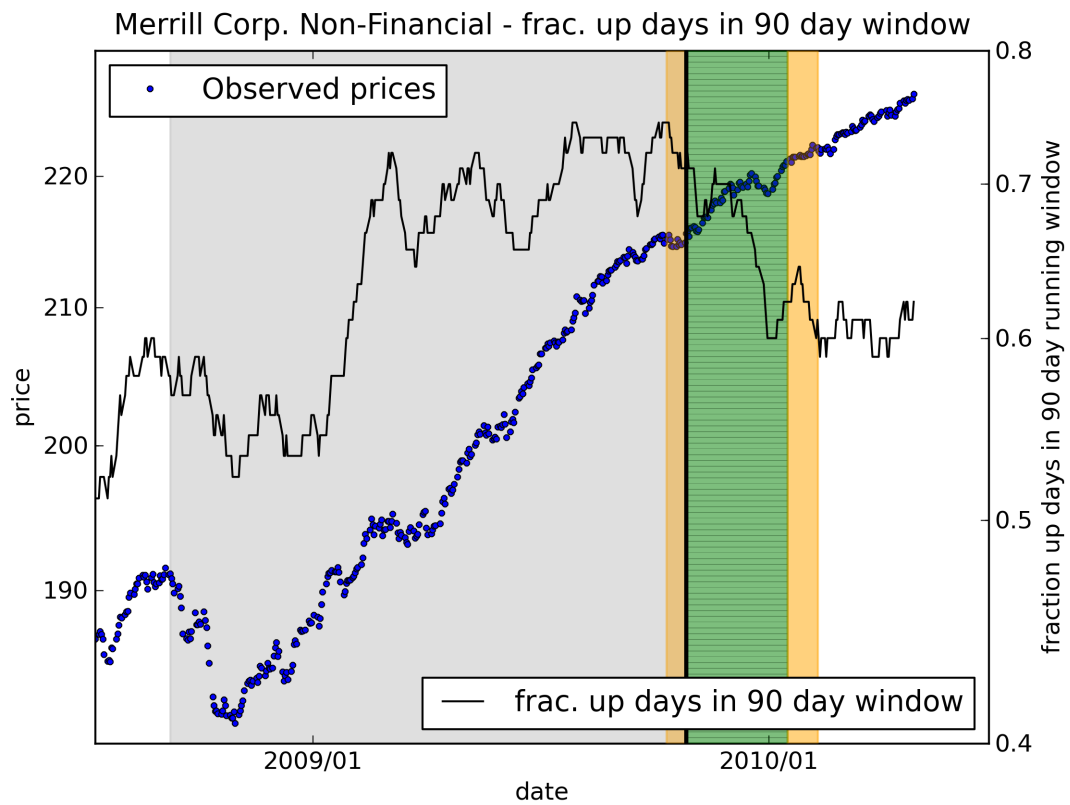


FIG. 6: On the data shown in Figure 5, we plot the fraction of days (right vertical scale) with positive returns as a function of the right-end time of a moving window of width equal to 90 days.

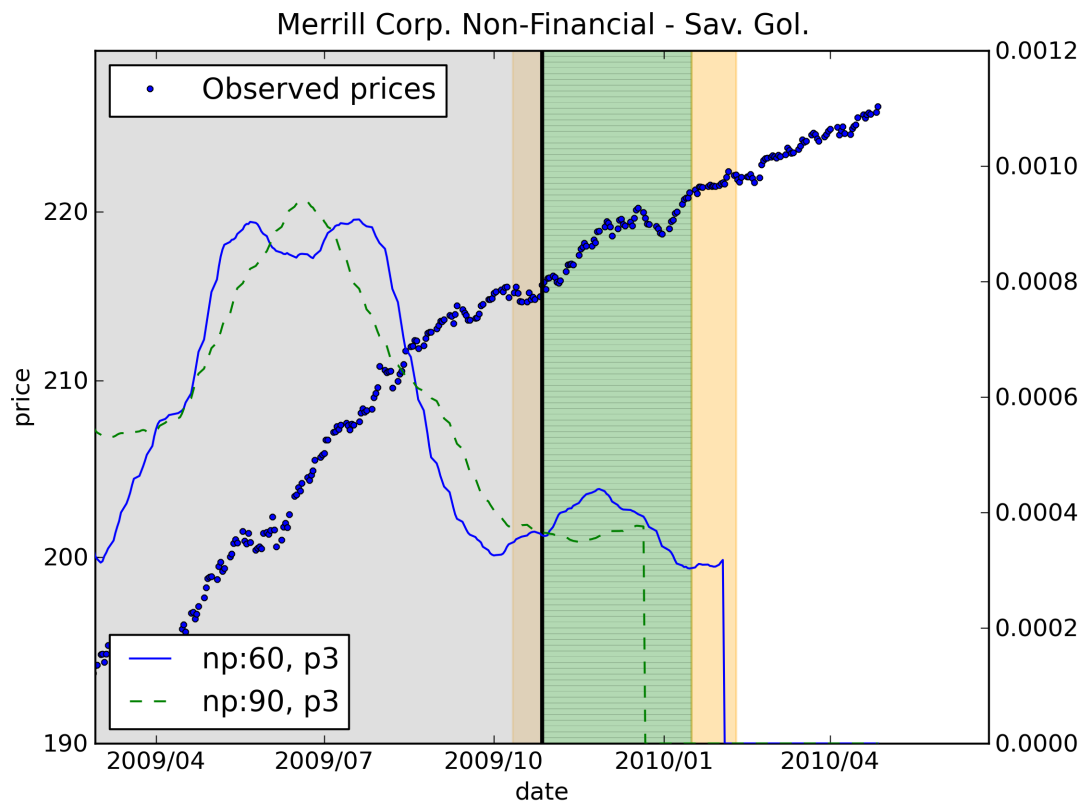


FIG. 7: On the data shown in figure 5, the dashed green line (respectively continuous blue line) give the smoothed growth rate of the Merrill Corp. Non-Financial index in the middle of a running window of 180 (respectively 120 days), as estimated with the Savitzky-Golay smoothing algorithm with a polynomial of order 3.

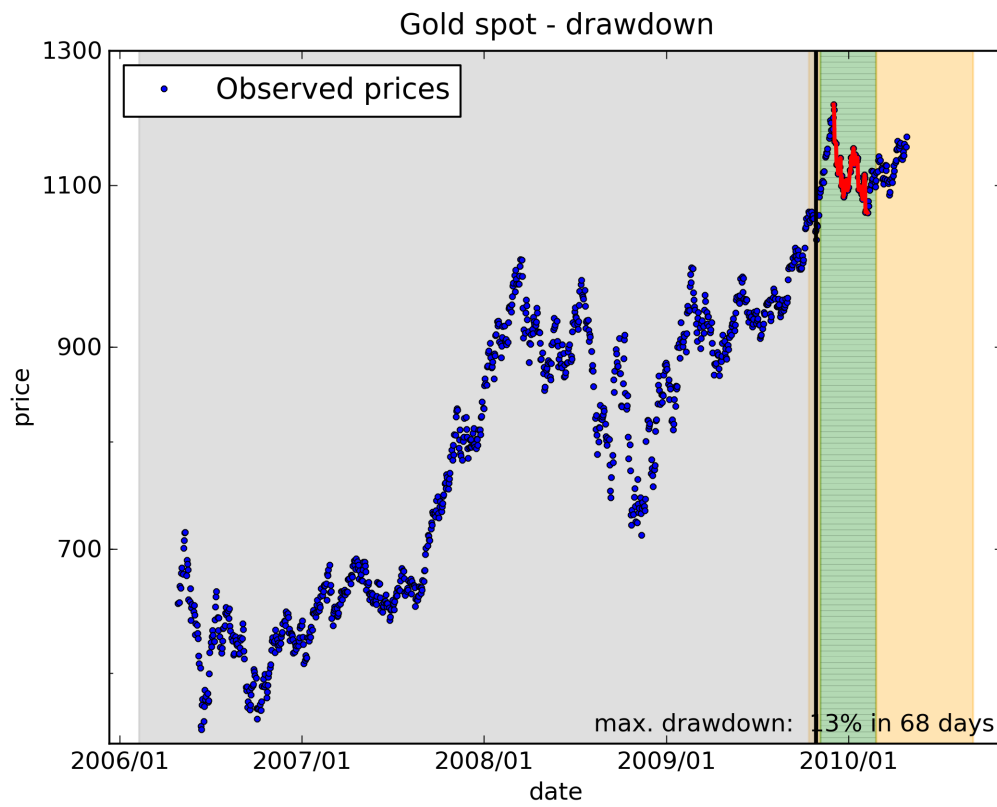


FIG. 8: Time series of gold spot price shown as filled blue circles, the 20-80% (respectively 5-95%) quantile intervals for the predicted end of the bubble and the subsequent evolution of the index. The black vertical line shows the time of the last observation used in the analysis. The red solid trace shows the largest drawdown that occurred after the forecast, 13% in 68 days.

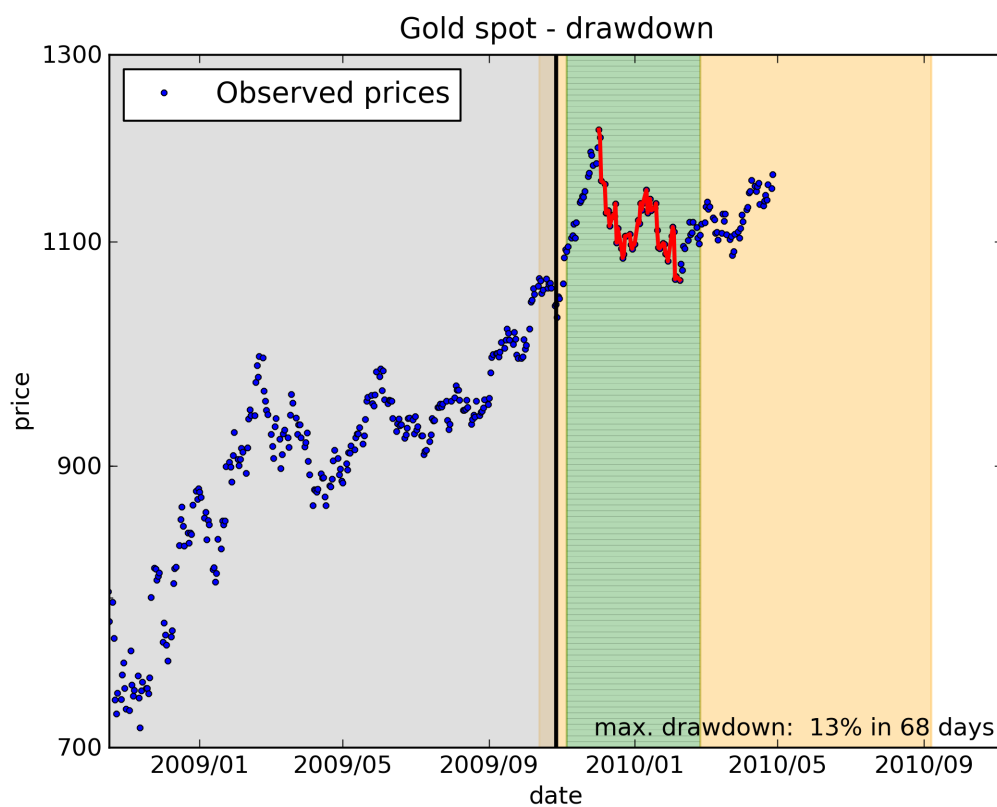


FIG. 9: Zoom of Figure 8.

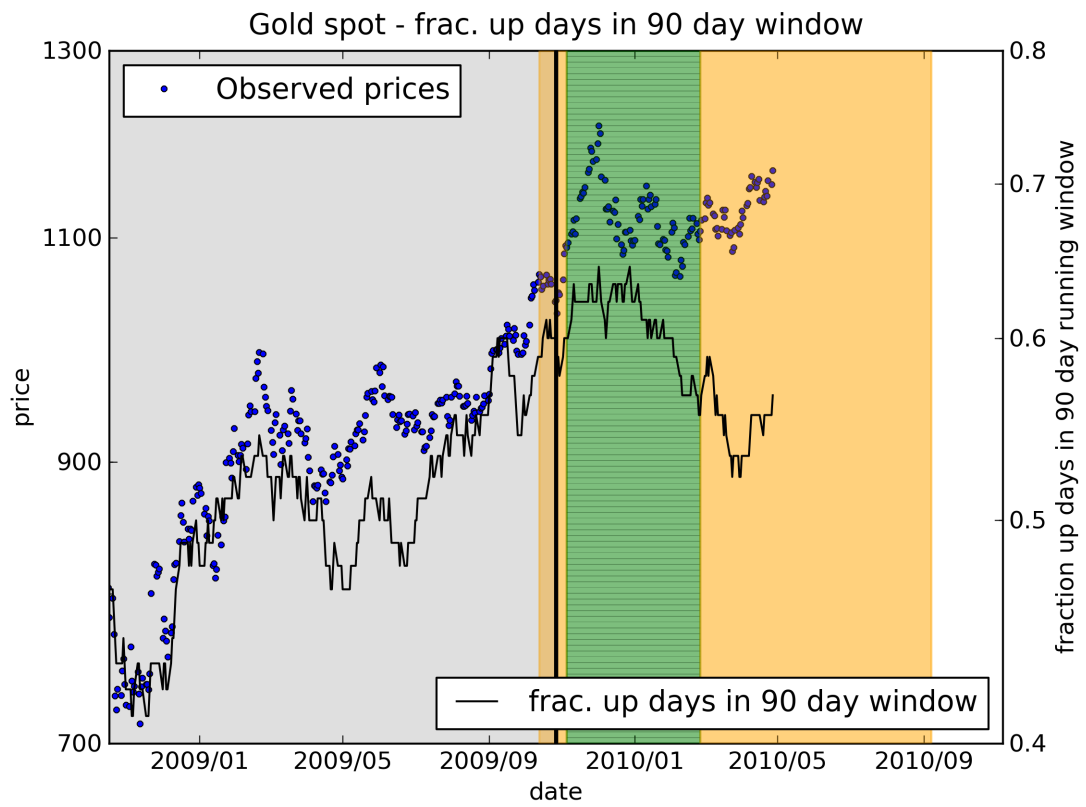


FIG. 10: On the data shown in figure 8, we plot the fraction of days (right vertical scale) with positive returns as a function of the right-end time of a moving window of width equal to 90 days.

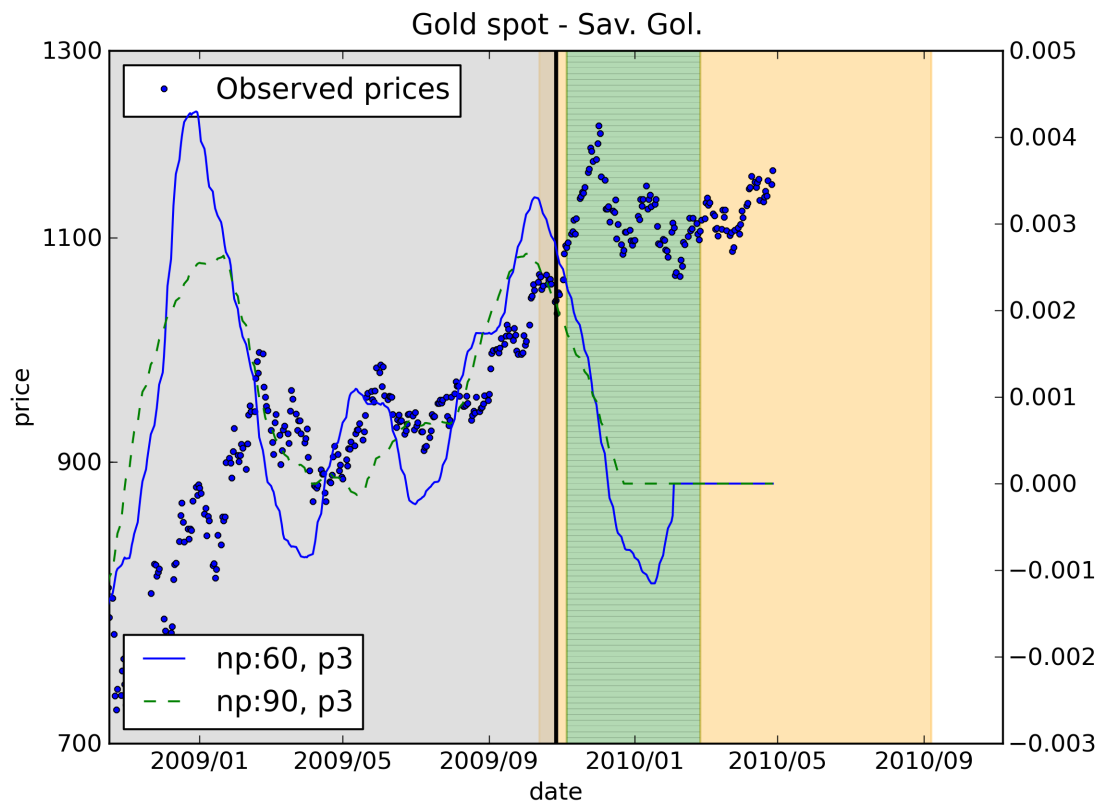


FIG. 11: On the data shown in Figure 8, the dashed green line (respectively continuous blue line) gives the smoothed growth rate of the gold spot price in the middle of a running window of 180 (respectively 120 days), as estimated with the Savitzky-Golay smoothing algorithm with a polynomial of order 3.

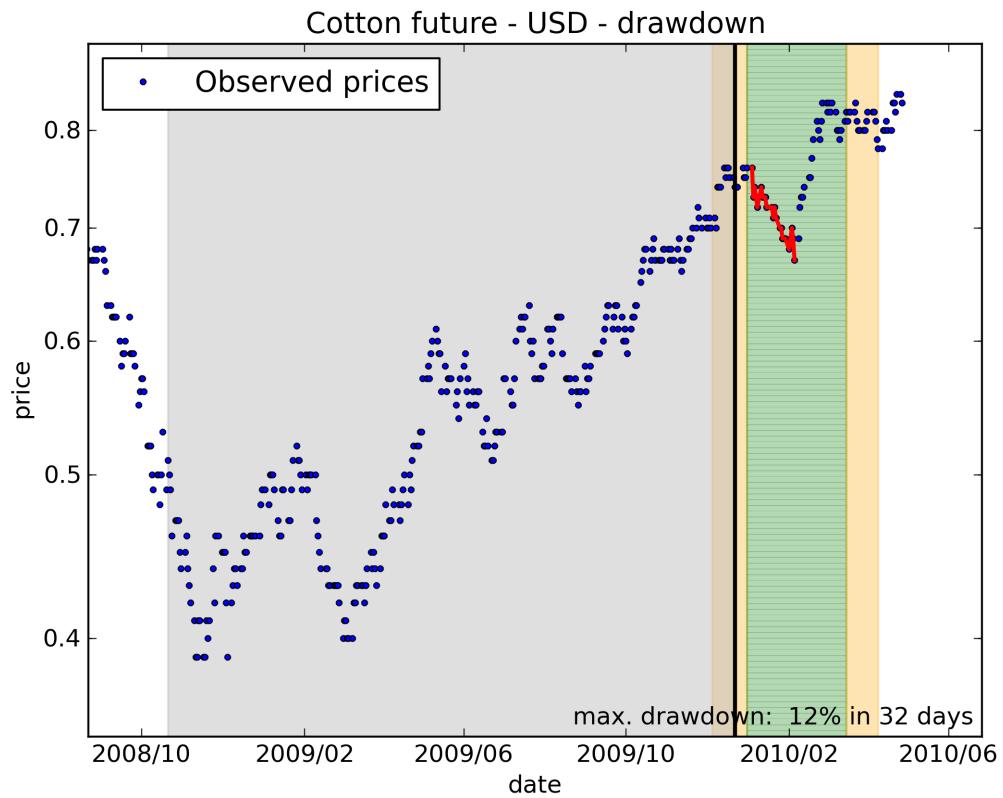


FIG. 12: Time series of the Cotton future price in USD shown as filled blue circles, the 20-80% (respectively 5-95%) quantile intervals for the predicted end of the bubble and the subsequent evolution of the index. The black vertical line shows the time of the last observation used in the analysis. The red solid trace shows the largest drawdown that occurred after the forecast, 12% in 32 days.

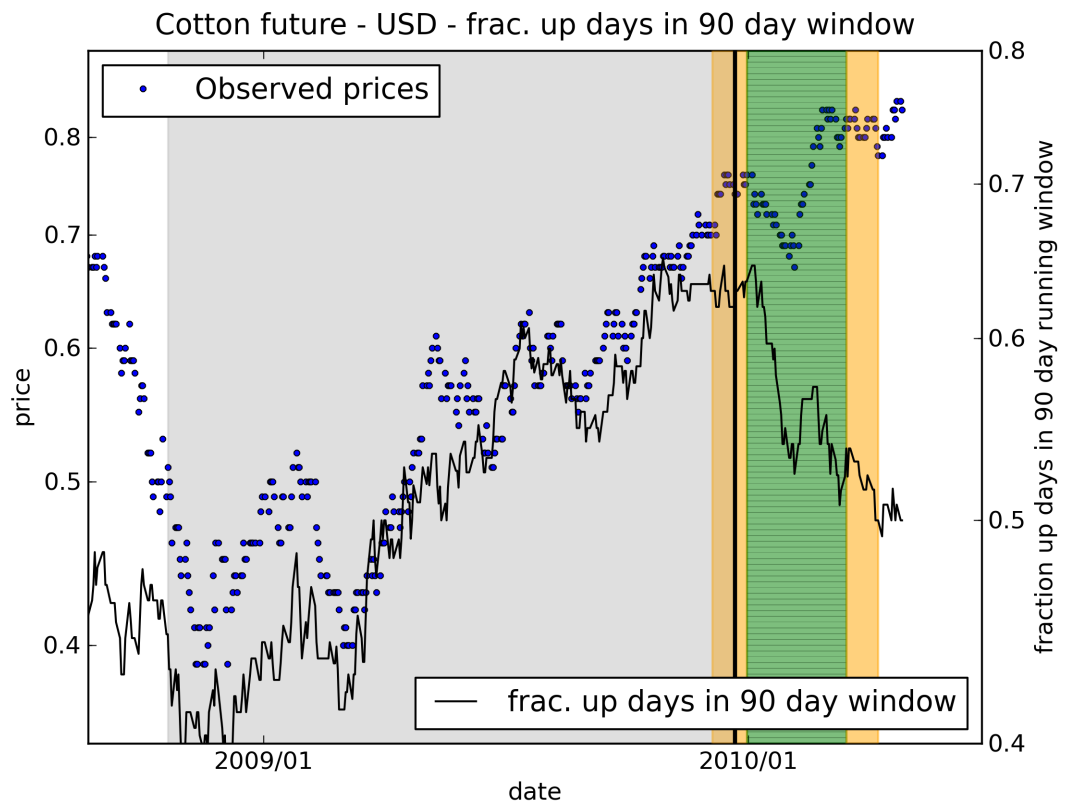


FIG. 13: On the data shown in figure 12, we plot the fraction of days (right vertical scale) with positive returns as a function of the right-end time of a moving window of width equal to 90 days.

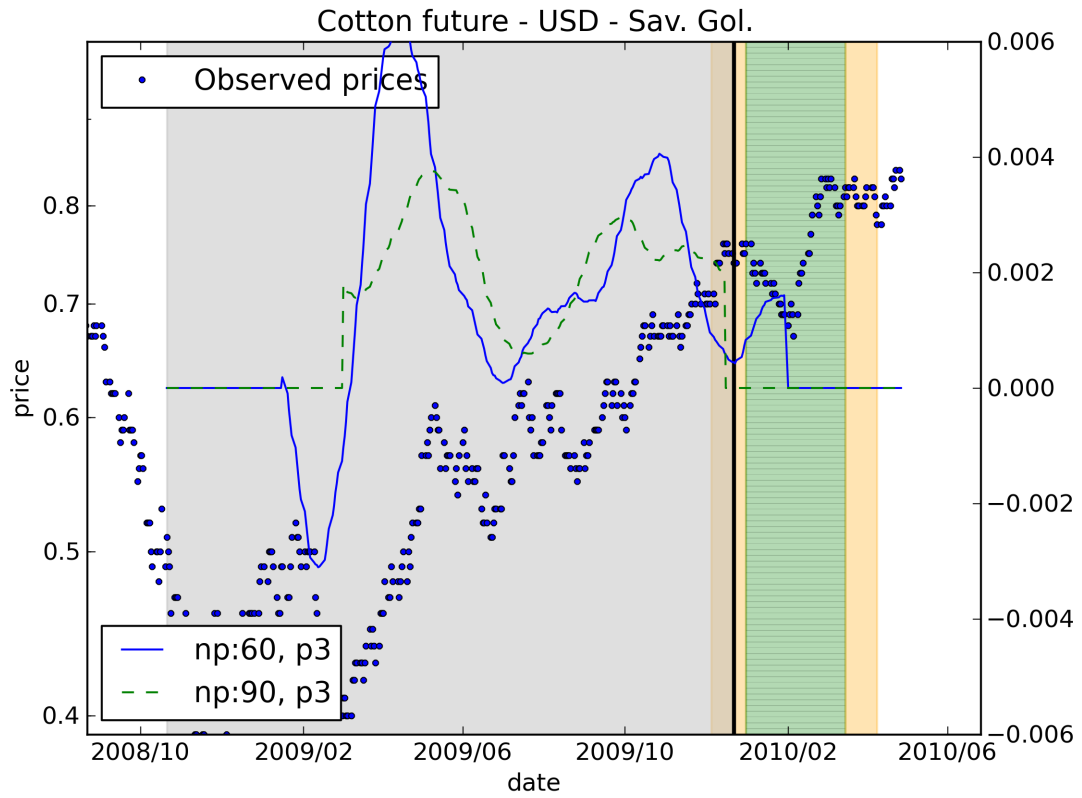


FIG. 14: On the data shown in Figure 12, the dashed green line (respectively continuous blue line) gives the smoothed growth rate of the cotton futures in the middle of a running window of 180 (respectively 120 days), as estimated with the Savitzky-Golay smoothing algorithm with a polynomial of order 3.

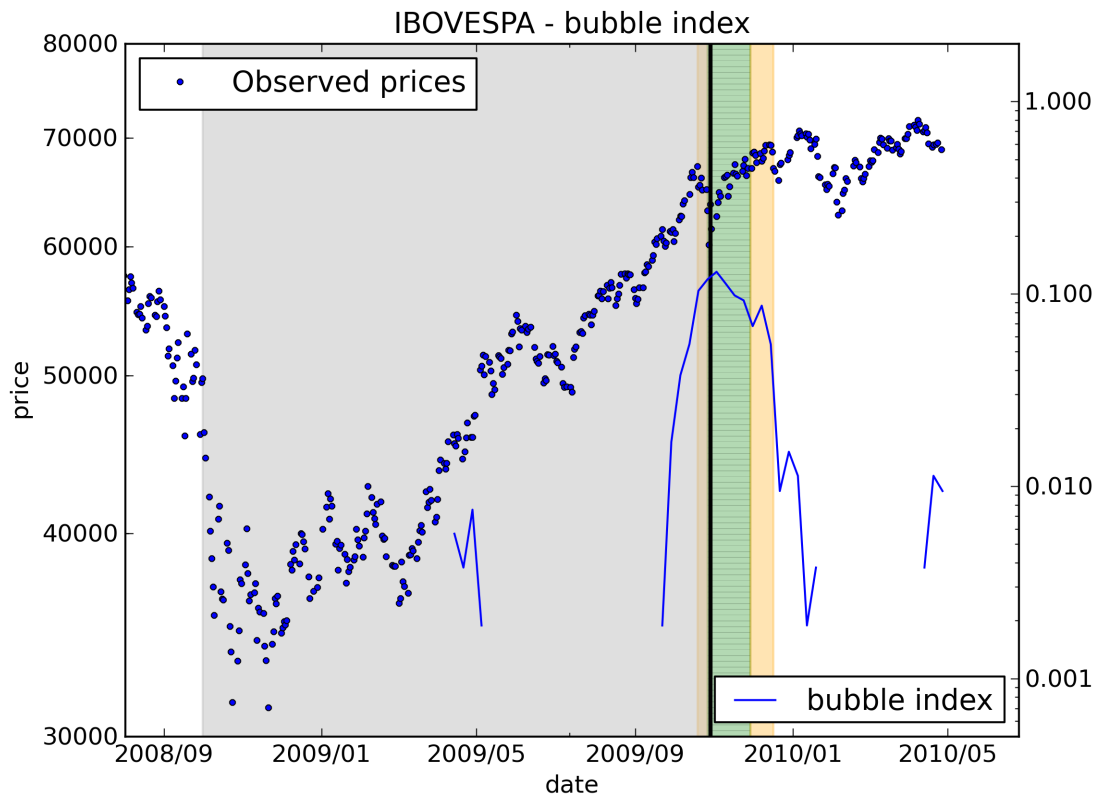


FIG. 15: On the data shown in Figure 1, our recently derived “bubble index”.

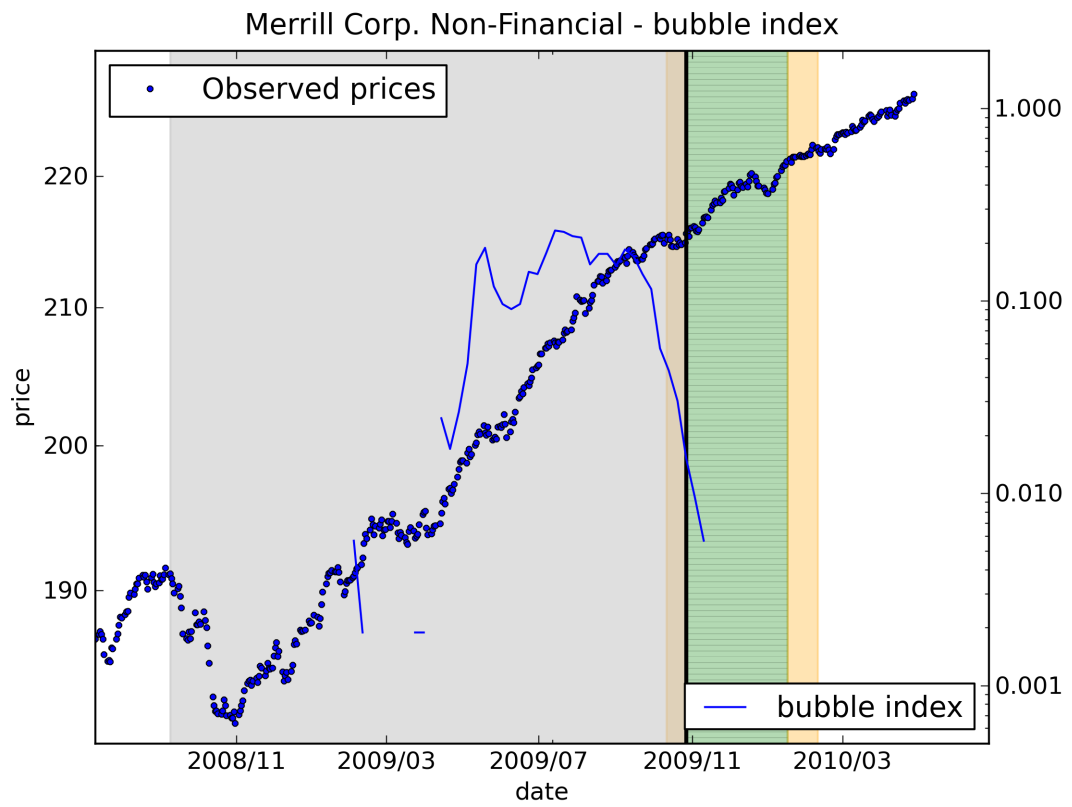


FIG. 16: On the data shown in Figure 5, our recently derived “bubble index”.

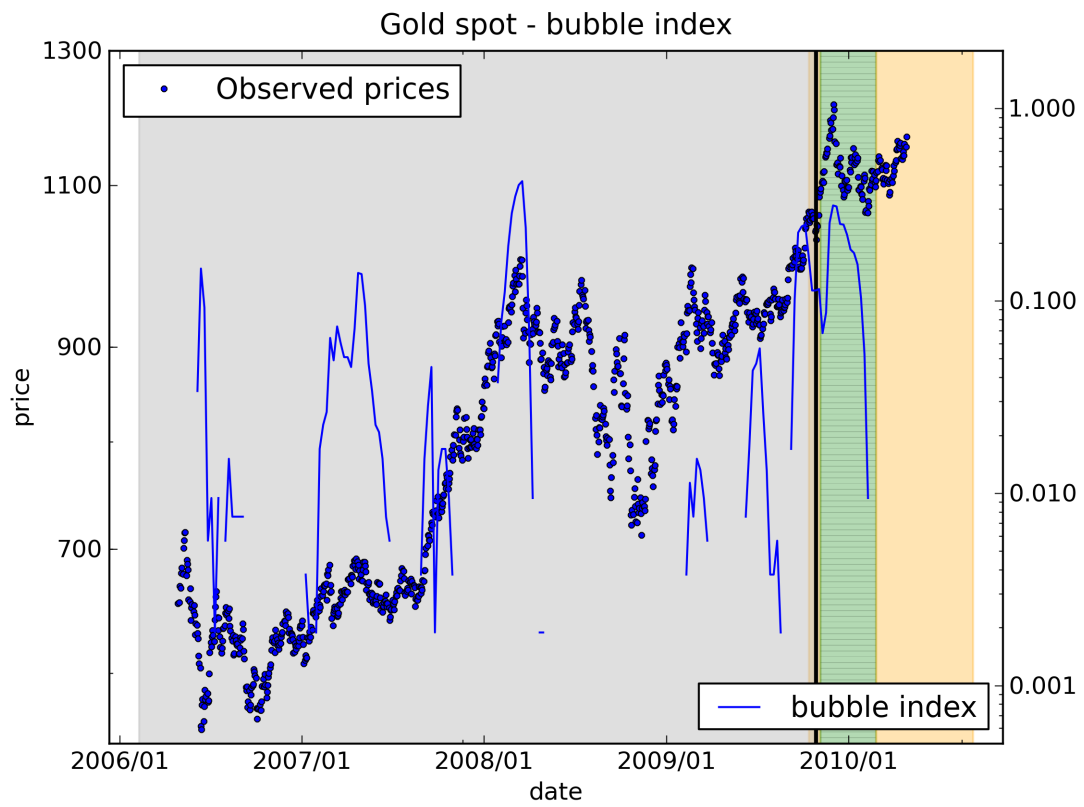


FIG. 17: On the data shown in Figure 8, our recently derived “bubble index”.

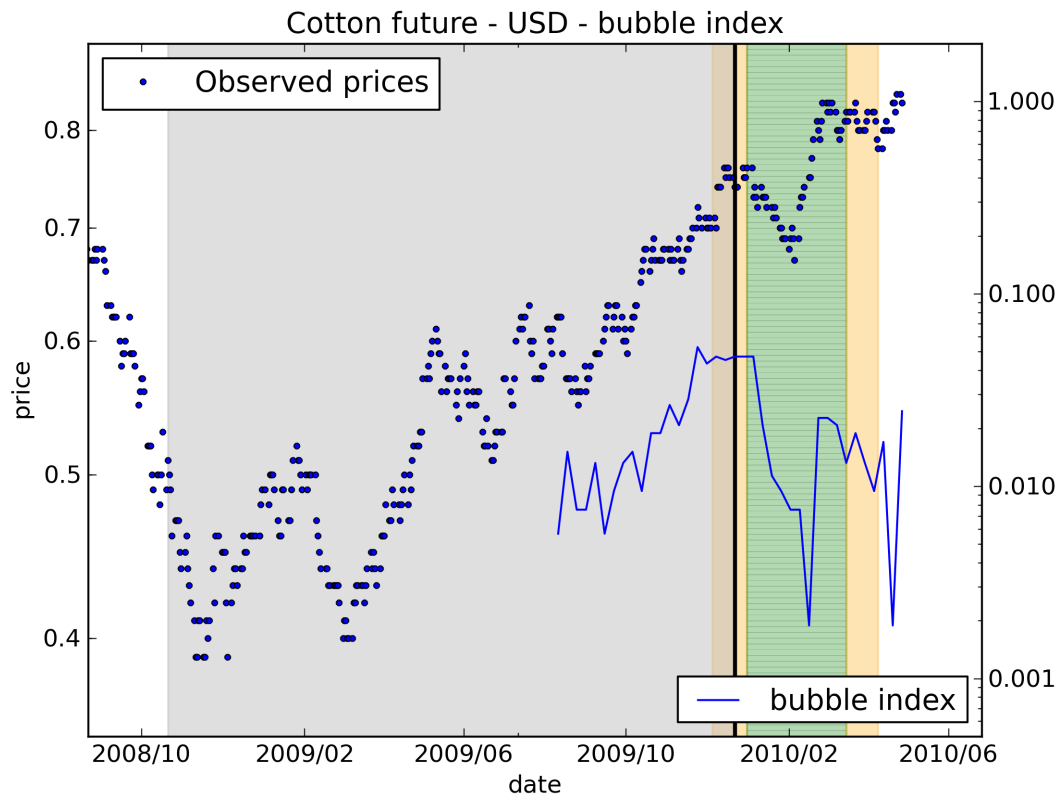


FIG. 18: On the data shown in Figure 12, our recently derived “bubble index”.