Detecting and predicting asset bubbles

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1. Introduction

The reason of this study is to add value on social, economic and financial sides in the function of exchange markets, to contribute to make more sustainable the connected operations of corporate finance for firms in more stable financial markets, giving the instruments to the subjects/regulators to inhibit the explosive behavior of prices in such asset should generate up and down of occupation/employment.

When the bubble grows everything seems good and the optimistic expectation for the future deceives investors on actual risks incurred following the mass behavior on investing in the asset involved in the bubble. But the bubbles bursts producing (Allen, Gale 2000; Herring, Wachter, 2003; Reinhart, Rogoff, 2009) a crisis, after default of firms and agents that borrowed funds to invest in asset with a strong difference in price and fundamental, unemployment, with pessimism and relative social costs.

In the last debates on how to predict the economic bubbles with the effects of its crush, different colleagues inquired on some key aspects: the detection of a change of price trend toward explosive state or high peaks and the identification of causes of the bubble.

Hence detected the instruments to discover the formation of bubbles probably governaments or regulatories should act, even if we are agree with Mishkin (2008) usually bubbles occur however, we believe a method to avoid the effects of bubbles will be find in literature, and with this spirit we contribute with Italian example.

We have the aim to verify the potency of the method not too complex, to detect the bubbles on Italian stock price index and to test the relationship between stock price trend and few factors suggested by literature and in which we believe. Every bubble is fed by specific characteristics for that period (Santos and Woodford, 1997) anyway some causes were repeated and we inquire on these.

The study is developed in three main section: the first is the review of literature, on definition of bubble through three dimensions, on the factors and existing models to

detect bubbles, with our assumptions. The second is on description of data used, the develop of analysis and the relative results , in the third we conclude.

2. Literature review

The bubbles and their dimensions

The question of the bubbles can be treated from different points of view, in literature, the bubbles have been studied and detected differently. Thus the first question has to be face is the definition of a bubble, the dimensions used to label a phenomenon as a bubble are the expectations (believe/behavior) of investors, the asset involved and the context, whose is usually characterized by several elements, in which the bubble grows.

The expectations of investors is the discriminating dimension through which the authors defy a bubble rational and non-rational. The rational bubble is the more supported hypothesis and is based on the idea that the purchases of assets are not explained by the fundamentals and the expected dividend, but from the expectation of buying that assets that will have an increase in price in the future, so the investors hope/believe to gain from the spread when they resell the assets bought before at a lower price (Cunado et al. 2005; Cerqueti, Costantini 2011; Al-Anaswah, Wilfling, 2011; Homm, Breitung, 2012; Asako, Liu 2013). The non-rational strand offers several alternatives as the irrational exuberance, near rational bubble and intrinsic bubbles to explain increasing of prices with explosive behavior (De Long et al., 1990; Chen et al. 1990; Shiller, 2000; Lansing, 2007;).

The assets on which a bubble could grows are different and should be commodities, securities or realities, looking at the bubbles before it emerges an alternation of the king of asset (real estate, shares, bonds…).

The context explains the concept of intrinsic bubbles. Before, in 1991, Froot and Obstfeld refused the rational bubble to explain the stoke prices increase and introduced the concept of the "intrinsic" bubbles, whose derive from all of exogenous economic fundamentals and none from extraneous factors as the rational. Chen et al. (2009) too tested long term data to verify that changes in earnings can predict stock returns in periods of absence of explosive peaks in stock asset prices, but always under the intrinsic bubble assumption, in fact they refused the studies on the rational bubble, that arises by extraneous causes. Every bubble as an own identity determined by the context with a specific mix of factors relative to that historic period. Nevertheless some factors are common and in literature there are attempts in classifying them

Thinking on the three elements necessary to define the bubbles we decided to follow the rational setting, in which the expectation of investors are not linked to fundamentals or dividend, well, the (il-)logical reason of investors, who buy in bubble scenario, is the believe of the rise or no-decrease of price of assets to 'keep the capital' or to gain reselling the assets in the futures, giving rise an explosive component in stock prices (Homm, Breitung, 2012). With this assumption it makes sense following that method detects bubbles from the price trend, in this study we will test it on stocks price of Italian stock exchange.

The factors advance a bubble

Probably when the bubble is going to burst it is the time in which the mass can't perceive the risk. Some specialized (analysts, regulators, traders, managers (boards of companies involved) people, instead, understand when the increase of stock price is anomalous and their behavior should be very different avoiding losses. As Hong et al. (2008) analyzed the communication process between advisors and investors in the tech-bubble and grouped the first in old-fogies and tech-savvies, both better informed than investors. They recognized the role of advisors in investment choices under two profiles: the well-intention of advisors and the excitation of investors inclined to avoid the pessimistic forecasting on no-actual tech-stock prices, without giving empirical supports. If the tech-savvies are informed it means they follow the values assumed by some factors, which should be them?

Reiterating every bubble is characterized by such specific features, we try to identify some others common features.

Shiller (2000) analyzing the bubble of 1996-2000, defined as the effect of irrational exuberance, identifies some factors as innovation (internet), decline of foreign economic rivals, cultural changes favoring business success or the appearance thereof, the parties of the country (Republican Congress, more pro-business), baby boom, expansion in media reporting of business news, expansion of defined contribution pension plans, growth of mutual funds, the decline of inflation, expansion of the volume of trade and the rise of gambling opportunities. The innovation is the element common to all studies tried to explore the factors anticipate a bubble, anyway such bubbles, for example the gold from 2009 to today, are only the consequence of lack of confidence in stock market, and in the

monitor of market on the heating of the price of an asset any dangerous variation of price can be neglected. We are not interesting in these kind of bubbles, which are not the cause of important crisis. Frehen et al. (2012) inquired on the causes of asset bubbles, focusing on the link between asset bubbles and innovation. The asset bubble analyzed is the South sea bubble and the Dutch windhandle of 1720, the sample is the cross-section of stocks in the London and Amsterdam markets. The analysis is developed on stock prices of 30, normalized to 1 and in logarithmic scale. After the description of the innovation whose affected the bubble raising, the research is developed in two steps: first the test of the presence of the bubble, than the test of theoretical prediction of innovation and clientele theories, through the analysis of behavior of investors. Fostel and Geanakoplos (2012) support the strong role of innovation in financial services. Innovation, however, for two reasons, one is the euphoric expectations and the other is the lack of knowledge about the effects in medium-long term. This is not easily measurable for the different manifestation of it in different bubbles, in fact innovation should be on the financial service relative to the asset, usually more traditional and in the industry of the asset, reflected on the product or the process.

We believe some factors should be common in the contexts in which the price of an asset swells. The factors identified to test the correlation are related to the availability of money (the cost), the money and quasi money growth and, the third variable, is the number of companies listed. The numerosity of variables should be increased inquiring financial freedom (source: Heritage), market capitalization of listed companies (5 of GDP) and consumer price, but not in this study, where the aim is to verify the model and regress the attendance of the bubble with few main factors as Asako and Liu (2013).

The model to detect a bubble

Researchers apply different/several statistic and econometric methods to asset price growth to identify the best model to discover the existence of a bubble. They usually test models for all asset price bubbles to verify (or control) they are transverse.

The different idea we want to support is the detection of bubbles through the trend of prices, not the analyses embodied the deviation from fundamentals. Because, if it's true that every bubble has different features, the common characteristic is the trend of price with picks, often very high. In this way the model to test the existence of the bubbles can be applied to all kinds of assets. To do this we should analyze bubbles on different assets, in this paper we try to develop this idea on the bubble of 2002-2007 and, thanks to the simpleness of test, we regress on several variables identified in literature as causes of bubbles and others suggested by us.

Cerqueti, Costantini (2011) start from the idea that the different cointegration tests applied to stock prices and dividends point out mixed results. They follow the authors, more recent, found unit roots results for the dividend-price ratio. All this unified to the different influence caused by the typology time series used. Herrera and Perry (2003) approach to panel data combined with Campbell (2000) present value model "the existence of stable relationship among stock prices, dividends and returns" has been verified. The results allow to state that the approach is valid for global analysis of the financial crashes related to bubbles, detecting them. In their conclusion the considerations are developed on relevance of global shocks respect to country-specific shock for returns change, the use of univariate analysis to detect a bubble in 18 OECD countries and the implications of results on private agents, investors policy makers and financial authorities. Cunado et al., (2005) analyzed the rational bubble existence in the NASDAQ composite index and using the Robinson's (1994a) test with semi-parametric method to examine the univariate properties of stock prices, dividends and stock prices-dividends ratio. The different sampling frequencies based on daily, weekly and monthly data gave different results: the bubble exists in weekly and monthly groups, not in daily one.

Al-Anaswah, Wilfling (2011) separate the literature on direct econometric tests to verify the presence of speculative bubbles from the indirect ones. After the description of the limits in the first method, the indirect literature is explained by the Markov-switching

models as the only methodologies to capture the shifts in generating process of time series, the developing of models are based on Hamilton (1989) and Hall et al. (1999). The results in their study are statistically significant in generating data of real-world stock-price contributing to the literature on the analyses of stock-prices bubbles dynamics, but finding the limit in in the lack of qualitative differences.

Phillips, Wu and Yu (2011) fix critical values (the share of the sample with around the 4% significance level) over that the prices of assets are in the bubble and detect the exuberance of investors through the unit root test, the sample is the Nasdaq stock price index. The model shows a weakness in detecting bubbles, but power in discovering the collapses.

Homm and Breitung (2012), based on rational bubble assumption, want to verify the ability of several models (Bhargava statistic, Busetti-taylor, Kim, Phillips/Wu/Yu, Chow-type unit root), with some modifications, on the detection of a bubble. The procedures has been run on NASDAQ Composite index. Their aim is to point out a test to detect "a change from a random walk to an explosive process". They are agree with Phillips, Wu and Yu (2011) , applying the Chow-type DF test, they detect an explosive behavior in US, UK and Spain in house price indices.

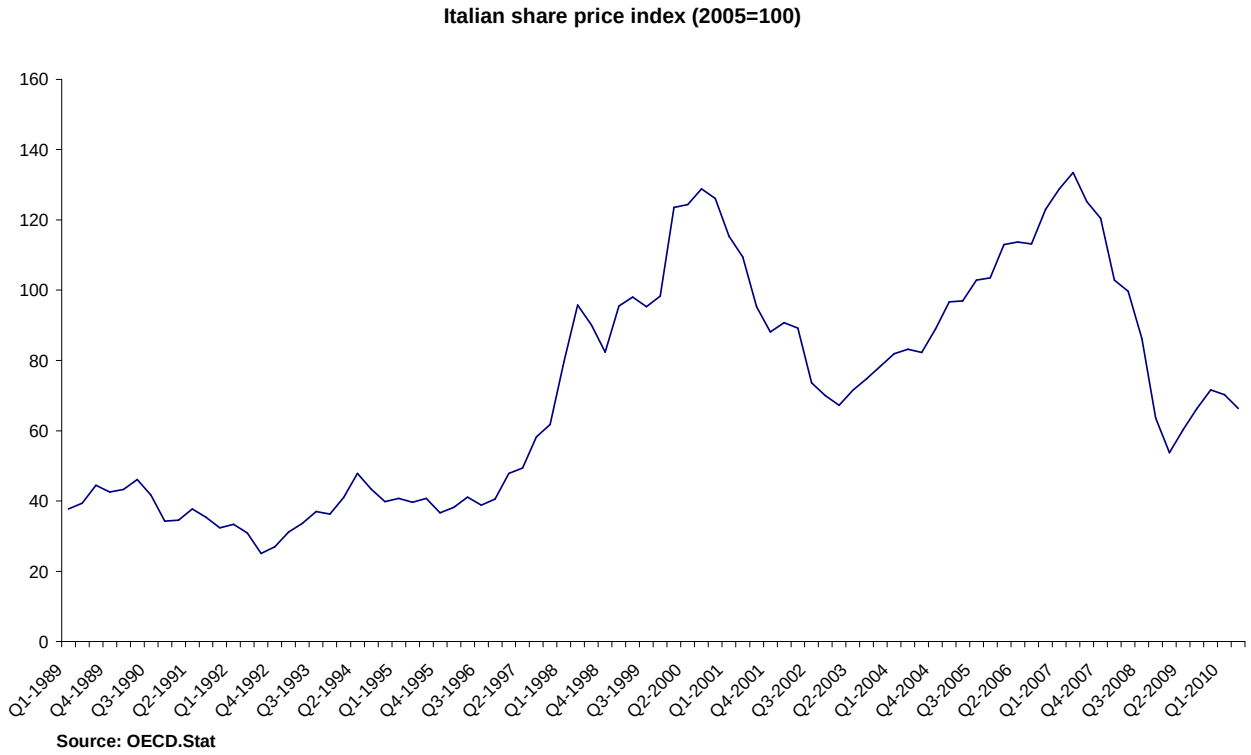
Asako and Liu (2013) to identify the speculative bubbles, and the relative break point, implement a recursive technique considering the values included in the bubble the ones too high, that are over the variance.

Herwartz and Kholodilin (2013) detect the bubbles when the stock indexes exceed one time or one and half the variance, so they reason on the value, more than the trend, assumed by the price of assets. The interesting contribution of this study to literature is the regression of price trend with such predictor factors grouped in macroeconomics variables, monetary variables, financials ratios and stock market characteristics, with the aim of detect and predict the periods of excess asset valuation through them. The analysis is developed in two periods recognized already in literature as periods with bubbles, and shows that financial ratios are the group of more explanatory variables. The analysis of prediction shouldn't regress only data from period of bubble pick, but could make more sense including a wider period divided in phases.

We are going to analyze, not the distance of price from fundamentals, but directly the trend/behavior of price. For two main reason, one as the test should be applied on different assets, considering that this distance should be affected by several reasons different from a bubble, the understanding of how a bubble grows matters the regulators to inhibit the bubble and the speculative behaviors and to ensure all investors frightened to be involved in these games.

3. Data and empirical analysis

In this section we analyse the time series of the share price index taken from OECD.Stat. We consider quarterly data from 1989:Q1 to 2010:Q2. A look at the plot of the series suggests that we are facing periodic collapsing bubbles (Evans, 1991), since there are two peaks, corresponding to the third quarter of 2000:Q3 and the second quarter of 2007:Q2: if there were bubbles, they have crashed in those.



Our objective is to identify variables that have predictive content for price bubbles that emerge at stock markets. In order to do so, we have to determine a chronology of speculative bubbles. The recent econometric literature addresses the issue of bubble detection by means of testing the random walk hypothesis for log-price series against specifications that allow for explosive stochastic trends (Phillips, Wu and Yu, 2001, Homm and Breitung, 2012): if the null hypothesis is rejected for the series of the log-price but one fails to reject the null hypothesis for the series of the dividend, this would suggest the presence of bubbles.

Further, in order to estimate the break date, Homm and Breitung (2012) proceed as follows. Assume that the stock market index $\{y_t\}_{t=0}^{T}$ initially follows a random walk but changes to an explosive process at unknown time $[\tau^* T]$, $\tau^* \in (0,1)$ and is the greatest smaller than or

equal to $\tau^* T$. To estimate τ^* it could be used the value $\tau \in [0, 1-\tau_0]$, $\tau_0 \in (0, 0.5)$, that maximizes the statistics

$$DFC_\tau = \frac{\sum_{t=[\tau T]+1}^{T} \Delta y_t y_{t-1}}{\tilde{\sigma}_\tau \sqrt{\sum_{t=[\tau T]+1}^{T} y_{t-1}^2}}$$

where $\tilde{\sigma}_\tau = \frac{1}{T-2} \sum_{t=2}^{T} \left(\Delta y_t - \hat{\delta}_\tau y_{t-1} \mathrm{I}_{\{t>[\tau T]\}} \right)^2$, $\mathrm{I}_{\{\}} = \begin{cases} 1 & \text{when } t > [\tau T] \\ 0 & \text{otherwise} \end{cases}$ and $\hat{\delta}_t$ is the OLS estimator of $\Delta y_t = \delta \left(y_{t-1} \mathrm{I}_{\{t>[\tau T]\}} \right) + \varepsilon_t$.

However, some cautions arise: first, as noted by Homm and Breitung (2012), if we include the observation after the peak the ability to detect the bubble will be very low. Since data shows more than one peak, one should split the sample in order to avoid to fail to detect the bubble, but at a cost of efficiency. Moreover, the method above does not indicate the burst of the bubble.

In order to generate a bubble chronology, we follow Herwartz and Kholodilin (2013) that identify stock price bubbles by means of the Hodrick-Prescott (HP) filter. Formally, a speculative price bubble is determined by means of an indicator function $\mathrm{I}(\cdot)$

$$B_t = I \left(c_t = \left(y_t - \tau_t \right) > \phi \sigma_c \right)$$

where τ_t is the HP trend obtained from the actual log real stock market index in time t, y_t. To estimate the trend component we use $\lambda = 1600$ as the HP smoothing parameter, which is typical for the smoothing of quarterly time series (Ravn and Uhlig, 2002). The unconditional standard deviation of the cyclical component, c_t is denoted σ_c. Furthermore, in equation above ϕ is the bubble threshold factor, determining the degree of overvaluation. If the cyclical component exceeds the predefined threshold, the respective market period is treated as a bubble $(B_t = 1)$.

Fixing ϕ =1.5, we find bubbles from 1999:Q4 to 2000:Q4 and from 2006:Q4 to 2007:Q4. Note that the two local maxima are respectively 2000:Q3 and 2007:Q2.

Once determined the bubble chronology, we rely on logit regression in order to determine the sign and significance of the influence of each factor previously selected in predicting periods of speculative bubbles.

All data are obtained from OECD.Stat. Real short term interest rate is obtained after subtracting the consumer price index. Money growth refers to M2, while Listed companies growth is the increase in the number of listed companies with respect to the previous period. Estimates were conducted by the R package.

Variable	Estimate	Std. Error	z-value	Pr(>|z|)	
(Intercept)	-0.7613	1.1410	-0.667	0.5046	
Real short term interest rate	-1.5295	0.6846	-2.234	0.0255	*
Money growth	-0.1444	0.0672	-2.148	0.0317	*
Listed companies growth	0.5058	0.2035	2.486	0.0129	*
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					

AIC: 35.634
Log-likelihood: -13.81698
Pseudo-R^2: 1-(-13.81698/-32.88541)=0.5798

It is worth noting that the estimated marginal impact of the growth of listed companies on the probability of a price bubble is positive, indicating that new companies may hide the emergence of price bubbles.

4. Conclusions

The mass phenomenon produces the economic bubble, if this mass is driven by the exuberance or the illusion of a sure (no-risk) and profitable investment, or yet by the wrong information, anyhow the regulators have to avoid the growing of the bubbles to make the financial markets efficient and the sustainable way to raise money or to invest funds. Sure, it's not a simple aim, above all as when the investors are in the bubbles they don't believe that it will burst. Several models are available in literature to detect the economic bubbles, we verify the potency of method suggested by Herwartz and Kholodilin (2013).

The sample analyzed is the Italian share price index from 1989 to 2013 enclosing the irrational exuberance period, that is recognized as a bubble and the values of the index in the period before the financial crisis of 2007. The model chosen by us in this study recognizes that period as an economic bubble as other authors did. We regress three variables in this study, the results show Real short term interest rate and Money growth are negatively correlate to

share price index picks and Listed companies growth are positively correlate. These are predictable results as explained in literature section, the decrease of cost of money implies the growth of capital available to be invested, while the increase of company, if it's read as the proxy of innovation (Frehen et al. 2012), reinforce the expectation on innovation as a factor predicts a bubble.

The literature treats about factors help to predict or to detect a bubble, probably future researches will inquire these factors considering the phases an economic bubble assumes. The born of the bubble, phase in which the bubble is still eventual, the index increase, and is consequence of the actions to give impulse to the economy (maybe after a crisis). If the bubble begin to grow the capitals flow toward the assets involved in the bubble and this is second face, the relevant factors are intrinsic. At last the index reaches the pick before the burst, the generalized euphoria makes investors blind on the forthcoming disaster, just few experts understand that the distance price-fundamentals is a risk and not an opportunity.

Anyway, in the next future, we are more interested to inquire how traders affect the formation of the economic bubbles, how the banks can defend themselves from the losses generated by the burst, how regulators can protect investors and companies in financial markets.

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