A Gold Bubble?

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Financial bubbles make good entertainment. One often reads speculation that a certain stock, commodity, or even housing is in the midst of a price bubble. For stocks, examples often come from initial public offerings (IPOs), the most recent being LinkedIn (see for example [3]), and a large collection of such occurred during the dot com mania around the turn of the century. Part of the problem in deciding whether an asset is experiencing a price bubble is that there is not a widespread understanding of what a bubble actually is, although there is plenty of expressed desire to detect one in real time. Indeed, the President of the Federal Reserve, Ben Bernanke, said during his confirmation hearings in 2009,

“It is extraordinarily difficult in real time to know if an asset price is appropriate or not”[1]

Commodities are also great examples of alleged price bubbles. A famous example was the oil price increases of 2007/2008. Nobel prize winning economist Paul Krugman wrote in the New York Times that oil prices were not a bubble, and two days later Ben Stein wrote in the same paper that they were. Without a quantitative procedure, experts often have different opinions about the existence of price bubbles. In this regard William Dudley, the President of the New York Federal Reserve, in an interview with Planet Money stated

“...what I am proposing is that we try to identify bubbles in real time, try to develop tools to address those bubbles, try to use those tools when appropriate to limit the size of those bubbles and, therefore, try to limit the damage when those bubbles burst.” [5]

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In regards to the aforementioned example of LinkedIn, Charles Evans, the president of the Federal Reserve of Chicago, is quoted by Reuters as saying just after LinkedIn’s IPO:

“I have no way of knowing that those aren’t just exactly the right valuations” [2]

Recently it is the price of gold, as the intriguing article in the New York Times by Steven M. Davidoff [4] discussed. The price of gold has recently reached rare heights, even in terms of inflation adjusted prices, so it seems reasonable to wonder if gold is in the midst of a price bubble. The three authors of this note have developed a model that can quantitatively determine whether or not an asset’s price is experiencing a bubble. The theoretical development of their model is given in [6], and it relies on the economic theory developed in [8] and [9]. In [6] the authors also back tested the model using the internet stocks during the dot com mania of 1998-2002, where it is widely believed that price bubbles were rampant. Therein they showed that some stocks were bubbles, while others were not. More recently in [7] the authors showed that in the initial trading period after its IPO, LinkedIn was in the midst of an asset price bubble. See also [2],[10].

This method for bubble detection depends on a mathematical analysis that determines when an asset is undergoing speculative pricing, in the sense that its market price is greater than its fundamental price. The fundamental price is that value someone would pay to hold the asset forever, and not retrade. The market price can differ if the asset is bought on speculation to retrade. The difference between the market and fundamental price, if any, is a price bubble.

Trying to determine the existence of a price bubble seems subjective and next to impossible. However, it can be shown that mathematics allows us to reduce this question to one of whether the asset price, under the risk neutral probabilities, is a random process known as a martingale, or whether it is in fact a local martingale. Risk neutral probabilities are those used to do option valuation as in the famous Black-Scholes formula, and they are distinct from the statistical probabilities.

Detecting the difference between a martingale and a local martingale is subtle, but the theory also allows one to reduce this question to whether a key calculus integral involving the asset’s return volatility is finite or not. If the asset’s volatility is too large, as measured by this integral, then a price bubble exists. The intuition is that speculative trading abnormally increases the asset’s volatility. To perform this test requires some sophisticated mathematics and
statistics, but it can be done using tick price data from the asset in question. This is what the authors used to analyze LinkedIn in [7] and the dot com stocks in [6]. Now we use it to analyze gold.

More specifically, first the tick price data is used to estimate the volatility of the asset in question. Then, a special technique is employed to extrapolate the volatility function to large values for the underlying asset’s price, where this information is not (and cannot be) available from the tick data. Using this information, if the volatility function increases to infinity as the stock price gets arbitrarily large, then whether or not there is a bubble depends on how fast this increase occurs (its asymptotic rate of increase). If there is no increase to infinity, then there cannot be a bubble within the model’s framework.

In the case of gold prices we used tick data obtained from Bloomberg, and we tested for the existence of a bubble from August 25, 2011 until September 1, 2011. We used prices per second with 73,695 data points. A graph of the spot price of gold for this period is given in Figure 1.

![Figure 1: Graph of gold spot prices](image)

Using the Florens-Zmiron estimator as modified in [6] to estimate the volatility function, we graph our estimate of the local volatility function for the gold price evolution, with its 95% confidence interval, and this is given in Figure 2.
As we can see from Figure 2 the local volatility function $\sigma(x)$ is not only not increasing quickly to $\infty$, it is not increasing as $x$ tends to $\infty$ at all. So our method tells us that under the risk neutral probabilities, the gold asset price is a martingale, and not a local martingale, and hence there is no bubble in the price in gold. Of course, our test only applies to the period we have investigated. If a bubble existed before our testing period, our procedure would not capture this. Nonetheless, for the period considered, the evidence is conclusive.

![Figure 2: Non-parametric Volatility Estimate for gold prices](image)

The purpose of this note is not simply to determine whether or not gold prices have (or had) a bubble, but rather to call attention to the existence of a recent method for determining when, or when not, a particular asset is the midst of a pricing bubble. Such knowledge is clearly of value to the Federal Reserve, as indicated by the quotes of Mr. Bernanke and Mr. Dudley. It is also of interest to banking regulators. When evaluating a bank’s capital reserves, if a given bank has large holdings of gold when gold is experiencing a price bubble, one might want appropriately to discount the value of the capital reserves accordingly. This is just one example of how this knowledge could be useful for banking stability and regulations. The knowledge of the existence of bubbles could also be helpful for long-term investors who would want to wait until a bubble plays itself out before making such a purchase.
References

[1] Ben Bernanke, Senate Confirmation Hearing, December 2009. This is quoted in many places; one example is Dealbook, edited by Andrew Ross Sorkin, January 6, 2010.

[2] Clare Baldwin, LinkedIn shares were a bubble: academic model, Reuters on line, June 2, 2011, available at the URL: http://www.reuters.com/article/2011/06/02/us-bubblemodel-idUSTRE75108X20110602


