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Do iron ore price bubbles occur?[☆]

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ABSTRACT

This paper uses the Generalized Supremum Augmented Dickey-Fuller test (Phillips et al., 2011) to examine whether there are multiple bubbles in iron ore price. The proposed method is convenient for a practical implementation of a time series and recognizes the initiation and termination of multiple bubbles. The empirical results indicate that four bubbles existed from January 1980 to December 2016 and that iron ore prices diverge from their intrinsic values based on market fundamentals. Through analyses, the first three bubbles can be explained by excess demand from China, persistent supply constraint, a high level of industry concentration and an annual benchmark pricing mechanism. The last bubble is mainly attributed to the negative influence from the global financial crisis in 2008. Therefore, the authorities should actively recognize bubbles and observe their evolutions, which favor iron ore price stabilization. These findings have important economic and policy implications derived from investigations of reasons for bubbles and assume corresponding measures to reduce the impact on the real economy due to the fluctuation in iron ore price.

1. Introduction

This paper investigates the existence of bubbles in the formation and evolution of iron ore price. Iron ore has proven itself to be a vital commodity in both the resources market and the real economy. In past decades, variations in demand, supply and the U.S. dollar exchange rate have induced drastic fluctuations in global iron ore price (Astier, 2015). Due to the strategic character of this resource, iron ore price is a significant economic parameter that deeply impacts a country. The volatility of its price produces a considerable impact on both importing and exporting countries. For instance, China has become the largest importer of iron ore since 2003, consuming more than 30% of the world's total production (Ma et al., 2013). More importantly, China's external dependence reached 78.5% in 2014 (Chen et al., 2016). China's increasing demand for iron ore accelerates its price unavoidably, resulting in a negative influence on purchasing power and economic development (Hellmer and Ekstrand, 2013). Meanwhile, the vast demand for iron ore also influences exporting countries. As Australia and Brazil export more iron ore to China, they have reduced their export to other countries such as the U.S., Germany and France (Hellmer and Ekstrand, 2013). In addition, some exporting countries such as Australia, Brazil and Canada, highly depend on commodity exports for foreign income, with their currencies even being described as commodity ones (Haque et al., 2015).

Iron ore is a core input in crude steel production and is utilized to manufacture steel products (Etienne, 2016). The prices of iron ore, such as many other raw materials and commodities, have been fluctuating widely since a few years, which has been widely noticed and announced in the media (Astier, 2015). Bubbles are usually accompanied by huge fluctuations in prices, which produces a negative impact on the demand and supply sides of iron ore. For example, iron ore costs account for the largest proportion of production and directly impact the profit of iron and steel enterprises (Astier, 2015). High iron ore prices also pull up the producer and consumer price indexes through steel products, which may trigger inflation and other economic problems (Yu, 2016). Meanwhile, when the iron ore price decreases, many mines could get into a difficult situation and may have to close their operations (Astier, 2015). Therefore, this paper investigates the reasons behind iron ore price bubbles and provides corresponding policies for demand and supply sides. The first reason is that the demand for iron ore pushes up its price. Sukagawa (2010) argues that the rapid growth in demand pushes its price to a high point. Furthermore, Wilson (2012) indicates that China's steel industry is developing rapidly, and its expansion brings up iron ore price. The second reason is that supply cannot cover the demand. Hellmer and Ekstrand (2013) show that, although the major exporting countries

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increase their production, the supply is still insufficient to cover the demand. Meanwhile, the high concentration in iron ore production is an important factor. Warell and Lundmark (2008) find the mergers between Rio Tinto and BHP-B exert more pressure on the iron ore price than demand does. BIG-3 players[1] account for 70–80% of global production and the ocean-shipping trade. Based on this monopolistic situation, the BIG-3 players can get higher premium prices (Pustov et al., 2013). Combined with the above analysis, the price of iron ore is not only determined by fundamental values, but also by other factors such as excess demand and high concentration. Finally, the U.S. dollar has a significant influence on global commodities, including iron ore. Choi et al. (2014) highlight how the shock from U.S. dollar depreciation has an accentuated effect on iron ore, crude oil and other commodity group price indexes. Ye and Li (2012) and Chen et al. (2016) prove that the U.S. dollar has the greatest negative effect on iron ore price. Zhang et al. (2016) assume a causal link between U.S. dollar and commodity prices such as iron, crude oil and gold.

This paper tries to detect rational bubbles in the international iron ore market. In general when investors are willing to pay more for the asset than they know is justified by its intrinsic value, then asset prices contain a rational bubble. At the same time, market practitioners expect to sell assets at higher prices, which makes the current high price an equilibrium one. Gurkaynark (2005) also develops the basic asset-pricing relation and rational bubble from a utility maximization problem and notes the assumptions embedded in the standard model. The main body of the paper tests for rational bubbles in the context of the present value model. This model has two components, a “market fundamental” part, which is the discounted value of expected future capital gains, and a “bubble” part. In this setup, the rational bubble is not a mispricing effect but a basic component of the asset price. According to Diba and Grossman (1987, 1988), if prices are integrated in levels but stationary in differences or exist in cointegration, no bubbles are indicated. However, one problem with the integration- or cointegration-based test is the econometric problems of detecting nonstationarity and estimating cointegrating relationships. This is a problem regardless of the outcome of the bubble test; many competing tests have different size or power properties and need not agree on the result. If the tests indicate the presence of a bubble, the correct interpretation is that they suggest the presence of something nonstationary in the iron ore price. This could be a bubble, but it could also be that the assumption made on the unobserved fundamental does not hold. Diba and Grossman (1987, 1988) also argue that although a rejection of the stationarity or cointegration conditions would not be proof of a bubble, failing to reject is proof of the nonexistence of bubbles. Evans (1991) demonstrates that this conventional cointegration-based test is not capable of detecting explosive bubbles when they manifest periodically collapsing behavior in the sample. Thus, more effective methods should be utilized to test whether multiple bubbles exist in the iron ore market.

The contributions of this paper to current literature are its application of the methods of Supremum Augmented Dickey–Fuller (SADF) and Generalized Supremum Augmented Dickey–Fuller (GSADF) to investigate possible bubbles in the international iron ore market. Iron ore prices have a persistent trend and presents huge fluctuations (Pustov et al., 2013). High volatility in iron ore prices may lead to bubbles and further produce disastrous consequences, so bubbles need to be detected, and useful alert mechanisms built for both market participants and regulators. According to Phillips et al. (2011), the SADF and GSADF tests perform better than previous economic methods based on the following analysis: (a) capture any explosive behavior manifested within the overall sample, and (b) ensure sufficient observations to achieve estimation efficiency. Since the GSADF test covers more subsamples of the data and has greater window flexibility, it is expected to outperform the SADF test in detecting explosive behavior in multiple episodes. This enhancement in performance by the GSADF test is demonstrated in simulations that compare the two tests in terms of their size and power in bubble detection. The paper also derives the asymptotic distribution of the GSADF statistic in comparison with the SADF statistic. A further contribution of the paper is to develop a new dating strategy. More specially, it uses the recursive procedure against critical values for the standard right-tailed ADF statistic and uses a first crossing time occurrence to date origination and collapse. The GSADF test presents in this paper is not simply ex post detection techniques but anticipative dating algorithm than can assist regulators in their market monitoring behavior by means of early warning diagnostic tests. Such warning systems ideally need to have a low false detection rate to avoid unnecessary policy measures and a high positive detection rate that ensures early and effective policy implementation. Because the advantages of the GSADF test, the detection of multiple bubbles in the iron ore market becomes effective and meaningful.

The rest of this paper is organized as follows: Section 2 shows the literature review. Section 3 introduces the asset-pricing model. Section 4 provides the methodology. Section 5 describes the data. Section 6 analyzes the empirical results and gives the policy implications. Section 7 drives the conclusions.

2. Literature review

Previous researchers have explored different methodologies to test potential bubbles. The asset-pricing model expressed by Lucas (1978) provides the basis for analyzing rational bubbles, when asset prices deviate from their fundamental values. Among relevant studies, the set of methodologies that have been employed to investigate the bubbles include the variance bounds test (Shiller, 1981; Leroy and Porter, 1981), the two-step test (West, 1987), the momentum threshold autoregressive (MTAR) model (Engle and Granger, 1987), the cointegration-based test (Diba and Grossman, 1987), the intrinsic bubbles test (Froot and Obstfeld, 1991), the Supremum Augmented Dickey–Fuller (SADF) test (Phillips et al., 2011) and the Markov Switching Augmented Dickey–Fuller (Markov Switching ADF) test (Lucey and O’Connor, 2013). However, the proof on bubbles mentioned by the above studies are unconvincing and the validity of these methods is doubted. Evans (1991) indicates that the unit root test has little power to detect periodically collapsing bubble, when the probability of collapse is non-negligible. Charemza and Deadman (1995) argue that the possibility of using the unit root test for investigating the presence of multiplicative processes with a stochastic explosive root. Shi (2011) repeats the work of Hall et al. (1999) and reveals how the Markov Switching ADF test is susceptible to false detection and cannot identify accurately the location when the bubbles start and end. Lammerding et al. (2013) present the ways the LPPL model forecasts the critical time of bubbles rather than explicitly tests on them. Zhang and Yao (2016) show that the MTAR model and the SADF test can only estimate whether there are cyclical bubbles. Compared with above methods, Homm and Breitung (2012) indicate that the Phillips et al. (2011) procedure performs better than other recursive (as distinct from full sample) procedures for structural breaks, and it is particularly effective as a real-time bubble detection algorithm. The SADF method is a formal statistical test of a bubble's existence, whereas the other approaches rely on the subjective judgement of the deviations from the fundamentals or from the moderate states. Phillips et al. (2011) argue that this method is especially effective when there is a single bubble episode in the sample data. However, when the sample period is sufficiently long, evidence of multiple asset price bubbles will occur often. The econometric identification of multiple bubbles with periodically collapsing behavior over time is substantially more difficult than identifying a single bubble. The difficulty typically diminishes the

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[1] BIG-3 players present the main iron ore producers include Rio Tinto, BHP-B and Vale.