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WHEN WILL BUBBLES OCCUR IN THE FINE WINE MARKET?

Abstract. *This paper detects the existence of bubbles in the fine wine market and investigates when the bubbles originate and crash. We utilize the Generalized Supremum Augmented Dickey-Fuller test (Phillips et al., 2012, 2013) and the empirical result indicates that there are four bubbles in the fine wine market when the price deviates from its intrinsic value. The three bubbles can be explained by the excessive demand of the emerging market, notably from China. The last bubble is attributed to the pound exchange rate plunging, mainly due to the Brexit. These findings are in agreement with the bubble model ameliorated by Gurkaynak (2008) considering that asset price can be decomposed to bubbles and fundamental parts. Therefore, in order to favor fine wine price stabilization, the regulators from this market should identify bubbles in order to notice their evolutions. The authorities should also manage the expectations of the public and reduce speculative behavior.*

Keywords: *Price Bubbles, Fine Wine, Generalized Supremum ADF test.*

JEL Classification: L66

1. Introduction

This study detects whether bubbles exist in the fine wine market and investigates when they are likely occurring and crashing. In recent years, investors have progressively been expressing an interest in more exotic and alternative asset investments, such as fine wine. Dimson *et al*. (2015) note that fine wine is a

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popular investment among high net worth individuals (HNWI), who hold on average almost 10% of their wealth in "treasure assets", such as art, wine, jewelry, and precious metals, etc. According to Wine Spectator, sales of major wine auctions increased from $90 million in 2002 to $381.7 million in 2017, an increase of 324%. This growth rate has accelerated in the last decade, while the price of fine wines has experienced a dramatic rise and the major fine wine price index tripled over the period 2001–2011 (Cardebat and Jiao, 2018). Dale *et al.* (2005) indicate that larger increases of asset price may include a substantial speculative part and this part is usually related to investors, which may probably imply bubbles. In addition, bubbles often occur with huge price fluctuations, which makes a negative effect on both the supply and demand sides in the fine wine market. Therefore, in order to stabilize the development of the fine wine market, this study detects reasons of market bubbles and offers relevant suggestions for this market.

Since the 2000s, the establishment of several wine investment funds enables people to entrust their savings to these companies, which then, reinvest their capital in fine wines. On the one hand, wine can be seen as a traditional financial asset, because wine can be stocked in the warehouse to be re-sold later at a higher price, generating surplus value. Sanning *et al.* (2008) note that wine can be considered as a financial asset due to its active trading markets, to the emergence of wine funds and to the behavior of some governments in favor of the introduction of fine wine in pension plans. Wine auctions development all around the world also reveals the growing financial interest for this asset (Masset and Weisskopf, 2015). Due to differences in image, quality, and reputation, wine also offers diversity in their prices. Therefore, fine wines can be an alternative financial asset (Cardebat and Jiao, 2018). On the other hand, wine differs from other classical financial assets on several features. To begin with, some costs are related to the trading of this asset, such as storage costs and insurance costs. Burton and Jacobsen (2001) indicate that additional storage costs and fees can reduce returns generated by this investment. Secondly, the quality and price of the wine depend on vintages, meaning that different climatic conditions may affect the final price of the wine, which is different from stocks and bonds. Thirdly, compare with traditional financial assets,

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wine has a double status: a consumer good and a financial asset, which means it can be consumed as a drink or offers the chance to speculate. Most recently, Masset and Weisskopf (2018) indicate that the status of fine wine has gradually grown from a consumption good to a tangible asset in its own right for a significant proportion of market participants. This transformation of the role of fine wine makes it possible to become a new speculative tool for arbitrageurs.

In general, the fine wine price may contain a rational bubble when investors are willing to pay more for them. Therefore, the main body of this study is to test rational bubbles for the fine wine market, on the background of the present value model, which has two sections, a "market fundamental" segment and a "bubble" segment. The fundamental part can be the present value of rational expectation of future values. In this context, the bubble phenomenon is an essential element of asset prices, not a mispricing consequent. Diba and Grossman (1988) note that there will be no bubbles when prices are stationary in differences or exist in cointegration. However, this conventional test cannot be capable of investigating explosive bubbles when they express periodically collapsing behavior during the sample period. To overcome this drawback, the paper utilizes more effective methods to examine when bubbles likely occur and crash in the fine wine market.

This paper has contributed to recent research in several ways. First, the analysis of the financial angle of the fine wine market is still in its infancy, and there is only scant research in this filed, such bubble phenomena. Therefore, this study sheds new light on previous researches, as we concentrate on the bubble detecting. Second, different from Fernandez *et al.* (2016) who implement a Heterogeneous Agent Model (HAM) to find the bubble in the fine wine market, we employ the Generalized Supremum Augmented Dickey-Fuller (GSADF) test (Phillips *et al.,* 2012, 2013) to detect explosive behavior in this market. These algorithms can be applied to any frequency data to test the presence of bubbles, whereas the other approaches rely on the subjective judgment of the deviations from the fundamentals or from moderate states. Another dedication of this paper is to apply a novel strategy in order to determine the dates of different bubbles, which utilizes a recursive process for critical values of the standard right-tailed ADF

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statistic and a first cross-time occurrence for date beginning and crash (Phillips *et al.*, 2012, 2013).

The empirical results are consistent with Gürkaynak's bubble model (2008) that asset price can be decomposed into fundamental and bubble parts. Specifically, the findings of this study reveal that there exist four bubbles in the fine wine market. The reasons behind the fine wine price bubble can be as follows. The first reason is that the fine wine demand from emerging economies has a considerable influence on the market price, especially in China. The second reason is that the continuous decline in the value of the dollar pushes up the fine wine prices (Jiao, 2016). Finally, the growth of investment funds, the money supply, and other factors begin showing their impact on fine wine pricing too (Jiao, 2016).

The remainder of this paper is organized as follows. Section 2 introduces the literature review. Section 3 explains the present value model and methodology. Section 4 describes the corresponding data. Section 5 discusses the empirical results. Finally, Section 6 concludes this paper.

2. Literature review

Previous investigation has appeared in this filed since fine wines become an alternative financial asset (Cardebat and Jiao, 2018). A first strand of the literature has considered the returns of storing wine. Burton and Jacobsen (2001) find that Bordeaux wines do not yield higher returns than financial assets, such as stock and bonds. However, Lucey and Devine (2015) argue that their Bordeaux and Rhone wine indexes yield returns excess Treasury bills and with risk below the stock market. Dimson *et al.* (2015) also note that the net annualized return on wine investments is 4.1% between 1900 and 2012, which exceeds bonds, art, and stamps.

The second strand of the literature has concentrated on the diversification abilities of fine wines within investment portfolios during tranquil and turmoil periods. Sanning *et al.* (2008) highlight that fine wine investment is able to diversify stock portfolios. Fogarty (2010) argues that adding fine wine investment to bond and equity portfolios can improve the risk-adjusted return of this portfolio. Masset and Weisskopf (2015) argue that including wine to an investment portfolio

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can increase its return while lowering risk. Kourtis *et al*. (2012) stress on the merit of diversification across the European wine markets, through investigating the nexus among the interest rates and stock markets. Bouri (2015) indicates that fine wine investments can be a safe method during the turmoil period given the hedging capability, which is different from world major equities.

The third strand of the literature has been devoted to the discovery of the macro-economic and financial determinants of fine wine prices. Cevik and Sedik (2014) claim that the macroeconomic variables have an important effect on determining fine wine price, particularly the considerable increase demand from emerging economies. Qiao and Chu (2014) point out the gross domestic product (GDP) in developed economies are able to be predicted based on the fine wine price. Faye *et al.* (2015) indicate that the global equity market has a significant impact on fine wine prices. Jiao (2016) finds that the decline in the value of the dollar has a vital influence on fine wine prices. Furthermore, Cardebat and Jiao (2018) highlight that the emerging economies increasing demand has an important effect on the pricing for fine wine, especially in China. In addition, the wine funds have enforced the price momentum since their appearance at the beginning of the 2000s (Lucey and Devine, 2015; Masset and Weisskopf, 2015).

Although there is a growing body of studies on the returns and determinants of fine wine prices, less is related to bubbles in this market. The appearance of bubbles on the wine market has been put forward by Jovanovic (2013); Dimson *et al*. (2015), but the reasons behind the bubbles have not received due attention. Fernandez *et al.* (2016) observe the crash behavior in the fine wine price and highlight the high volatility as Dimson *et al.* (2015). Since the early 2000s, fine wine has been deemed an alternative financial asset and the price fluctuations are more frequent. However, there is only a few research on the financial analysis of the wine market, such as bubble phenomena. Especially in recent years, the fine wine price has been at a high level. Therefore, this study attempts to achieve progress in this field and expects to offer new insights to the current literature, to the further understanding of bubbles in the fine wine market.

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3. Present value model and methodology

According to Gürkaynak (2008), it is widely accepted that asset prices or commodity prices might deviate from their fundamental values because of "speculative bubbles", "fads" or "information bubbles". Under rational expectations and present value model, the price of fine wine is equal to its discounted expected fundamental value. Therefore, we can obtain the following equation:

$$P_t = \left(1+r_f\right)^{-1} E_t\left(\delta_{t+1} + U_{t+1}\right) \tag{1}$$

where r_f stands for the free-risk rate. P_t and E_t indicate the fine wine price and the expectation in the stage *t*. The returns and the invisible part in the stage $t+1$ are represented by δ_{t+1} and U_{t+1}.

Accordingly, the equation is written as the following:

$$P_t^f = \sum_{i=0}^{\infty} \left(\frac{1}{1+r_f}\right)^i E_t(\delta_{t+i} + U_{t+i}), \quad for\ i = 0,1,2\cdots n \tag{2}$$

where P_t^f and δ_{t+1} stand for the fine wine market fundamental price and the returns in the time $t+i$ respectively. Equation (2) shows the determinants of the basic price without bubbles. It also implies that even if P_t and δ_t are difference stationary, the two series P_t and δ_t should be cointegrated and therefore ruling out the possibility of bubbles. Moreover, one general solution from a potentially infinite class in Equation (2) can be given by:

$$P_t = P_t^f + B_t \tag{3}$$

where B_t represents for the "rational bubble" and equals to:

$$B_t = \left(1+r_f\right)^{-1} E_t\left(B_{t+1}\right)$$

Equation (3) denotes that the fundamental model has two parts, a "market fundamental" part and a "bubble" part. When identifying $B_t = 0$, it implies no bubbles and this solution is a special case. However, if $B_t \neq 0$, it implies that there is a bubble and this bubble will continue to grow due to the rational investor's expect until it bursts.

According to the explosive property of bubbles, Diba and Grossman (1988)

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propose to test the stability of the logarithmic sequence of asset prices and visible basic market prices to determine the existence of bubbles. Adding an explosive alternative hypothesis in the standard ADF test or Phillips-Perron test (Phillips and Perron, 1988) is the principle of this traditional test. Specific principles considering the following model:

$$\Delta p_t = \alpha + \beta p_{t-1} + \sum_{i=1}^{k} \varphi_i \Delta p_{t-i} + \varepsilon_t \qquad (4)$$

where P_{t-1} stands for the logarithmic sequence of the asset price $\varepsilon_t \sim NID(0, \sigma^2)$ and k represents the period of the lags. The null hypothesis of the unit root is $\beta = 1$, meaning that P_{t-1} is a unit root process (the difference of P_t is stationary). The alternative hypothesis is $\beta > 1$, suggesting that P_{t-1} is crashing process (the difference of P_t is not stationary). However, when a process experience changes from a unit root to a lightly explosive root, this conventional test has discriminatory power in detecting this process (Phillips *et al*., 2012). This sensitivity appears to be greater than the left-tailed unit root tests against stationary alternatives. Thus, the conventional tests have limitation in investigating bubbles when a time series has multiple crashing behaviors. In order to surmount this drawback, Phillips *et al.* (2012) provide the supreme of recursively determined ADF *t*-statistics test to consider an explosive behavior.

Homm and Breitung (2012) indicate that Phillips *et al*. (2012) test is an effective way to detecting cyclical crashing behavior and is robust against structural breaks considering a potential bubble bursting. Their method is to repeatedly estimate the ADF model over the forward expanded sample period and examine the hypothesis based on the highest value of the corresponding statistical sequence. The window r_w changes from r_0 to 1, which represent the smallest size and the largest one respectively. When r_w=1 it indicates the subsample extends to the full sample. In general, the starting point r_1 of the sample sequences is fixed at 0. Based on the equation $r_2 = r_1 + r_w$, the ending point of each sample r_2 depends on r_w, ranging from r_0 to 1. Thereby, the ADF statistic for the sample ranging from 0 to r_2 can be denoted by $ADF_0^{r_2}$. The forward recursive supremum ADF (SADF) statistic is defined as the following equation:

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$$SADF(r_0) = \sup_{r_2 \in [r_0,1]} \{ADF_0^{r_2}\} \quad (5)$$

The SADF algorithm is particularly valid for detecting the bubble when there is only one bubble episode in its time series. However, there may be numerous price bubbles in the full sample. At this time, the SADF test might suffer from the existence of more than two bubbles. This disadvantage could become clearer when detecting bubbles in the more frequently changing markets or long period series. To address this disadvantage and detect multiple bubbles, the generalized supremum ADF (GSADF) test is used depending on the flexible window size (Phillips *et al*., 2012, 2013). This test adopts a feasible range of flexible windows by shifting both the beginning and finishing point of the sample rather than fixing the beginning point of recursion, extending the total sample period, which is different from the SADF test. Due to greater window flexibility, the GSADF test could cover more subsamples of the data, which causes it to perform better than the former test when there are more than one bubbles.

Same as the SADF test, the algorithm of GSADF inherits the idea of repeatedly operating the ADF test regression on a sample sequence. The GSADF test allows the outset r_1 range from 0 to r_2-r_0, and the ending point r_2 change r_0 to 1. Considering two test's size and ability in clarifying the crashing behavior in some periods, the excellent manifestation of the GSADF test has been proven. Phillips *et al*. (2012, 2013) argue that the largest ADF statistic is the feature of the GSADF statistics with the starting and ending points which range from r_1 to r_2, and this statistic is denoted by *GSADF* (r_0). That is,

$$GSADF(r_0) = \sup_{r_2 \in [r_0,1], r_1 \in [0, r_2 - r_0]} \{ADF_{r_1}^{r_2}\} \quad (6)$$

When the null hypothesis is a stochastic process with an asymptotically insignificant drift and this model contains an intercept part, the finite distribution of this statistic is:

$$\sup_{r_2 \in [r_0,1], r_1 \in [0, r_2 - r_0]} \left\{ \frac{(1/2) r_w [w(r_2)^2 - w(r_1)^2 - r_w] - \int_{r_1}^{r_2} w(r) dr [w(r_2) - w(r_1)]}{r_w^{1/2} \{ r_w \int_{r_1}^{r_2} w(r)^2 dr - [\int_{r_1}^{r_2} w(r) dr]^2 \}^{1/2}} \right\} \quad (7)$$

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where $r_w = r_2 - r_1$, following a standard Wiener process. This process has independent increments with the distribution $w(r_2) - w(r_1) \sim N(0, r_w)$. The statistics of GSADF and SADF tests will follow a standard normal distribution if the true process is a random walk. And Phillips *et al*. (2012, 2013) reach the asymptotic critical values of the ADF statistic with the Monte Carlo simulation, which confirms that a random walk exists in the process. Since the standard Winer process is stochastic and continuous, it can only generate a limited number of finite points. Supposing that periods such as $n_1, n_2, n_3 ... n_N$ are equally spaced, it would generate a Gaussian random variable with variance 1/N and mean zero at each point. The right-tail critical values of the SADF test are smaller than the GSADF test, indicating that the latter test is superior to the former. (Phillips *et al*., 2012, 2013). We can obtain the asymptotic critical values through multiple simulations, and the bootstrap algorithm can be applied to calculate the limited sample distributions of the GSADF and SADF tests. It confirms that this algorithm works well and could identify the crashing behavior through the procedure of Monte Carlo simulation. Pavlidis *et al*. (2012) indicate that the simulation methodology does not need the procedure in line with fundamentals and this is not influenced by a possible explosive root of the asset price.

The main merit of the GSADF and SADF tests is that allows us to examine for the possible non-stationary behavior of time series to prevent mild crashing alternatives. Instead of fixing the outset of the sampling period, a different method is taken, causing the GSADF test to extend the sequence by changing the start and the endpoints of the sampling period within a feasible and flexible window. Due to the advantages of these tests, the detection of more than one bubbles in the fine wine market can be effectual and significant.

4. Data

To detect bubbles in the fine wine market, we consider the Liv-ex Fine Wine Investables index[1] that obtained from London International Vintners Exchange

[1] Liv-ex Fine Wine Investables index started from 1988, which is one of leading fine wine price indices, composed of most dominant investment-grade wines.

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(Liv-ex) as the market price, which tracks the most investable wines in this market (Jiao, 2016). The data covers from January 1988 to December 2017 which has been available to the public since 1988. The length of the sample interval captures information on the development of the fine wine market. In addition, the sampling period includes the Asian financial crisis, Globe Financial Crisis, the European debt crisis, and the Brexit[2], which may lead to furious price fluctuation. Figure 1 illustrates the fine wine price has experienced huge fluctuation since 2005 when several large investment funds were established in the fine wine market (Jiao, 2016). Moreover, the establishment of investment funds accelerates the pace of financialization of this market and makes fine wine investment more accessible (Bouri *et al.*, 2017). The market price rallied between 2005 and 2008, while the price was low and stable prior to 2005 except the period of the Asian financial crisis. After a brief decline affected by the subprime crisis, the market price rebounded again, reaching a peak of 369.81 on June 2011. However, the slowdown of economic growth in emerging economies since 2011 has engendered negative effects on the fine wine market and the price has fallen sharply to 300.35 just five months later. And then, the speed of the decline was gentle and it fell gradually to 260.04 in early 2016. Due to the Brexit in 2016, the pound exchange rate plunging led to increased purchasing power for fine wine in the emerging economies, which produced a huge demand for fine wine. Therefore, the price skyrocketed again and increased fiercely to 341.28 since then. Generally, the fine wine price has soared and fluctuated significantly since the financialization of the fine wine market. The market price has reached to about twenty times more than the original means that prices for fine wines may include considerable bubbles.

5. Empirical Results

According to the principle of GSADF and SADF bubble tests proposed by Phillips *et al*. (2012, 2013), this paper turns to account the SADF test and then apply another method to detect the bubble phases in the fine wine market. The critical values for both tests are obtained through Monte-Carlo simulations with

[2] Brexit is the impending withdrawal of the United Kingdom (UK) from the European Union (EU).

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10,000 replications. The summary of both tests displayed in Table 1 indicates that statistics for the full data series always appear to exceed their respective 1% right-tail critical values (i.e. 6.521>1.929, 13.451>2.765). Therefore, obvious evidence from the GSADF and SADF tests provide evidence that prosperity exists in the fine wine market, allowing us to highlight the possible bubbles.

Table 1. Results of the SADF and GSADF tests

	SADF	**GSADF**
Liv-ex Fine Wine Investables Index	6.521***	13.451***
	Critical value	
90%	1.139	1.952
95%	1.408	2.231
99%	1.929	2.765

Notes: This table reports the SADF and GSADF tests for the null hypothesis of a unit root against the alternative of an explosive root. ***, ** indicates significance at the 1% and 5% level respectively.

Utilizing the GSADF test, we draw the estimate of the fine wine market price, with 95% confidence intervals. In Figure 1, the bottom curve is the GSADF statistics. The middle line indicates the GSADF statistics with 95% confidence intervals. The upper one represents the fine wine market price. Specifically, the result in Figure 1 indicates, at the 5% critical level, that there are four fine wine price bubbles during the analyzed period (1994:05-1998:04; 2005:08-2008:08; 2009:08-2012:05; 2016:04-Now). Phillips *et al.* (2012, 2013) confirm that the GSADF procedure performs better than another test. According to this argument, we can conclude that there is evidence of multiple bubbles in the fine wine market. Therefore, we further identify the bubbles and detect the reasons in this market.

The first bubble started in May 1994 and collapsed in April 1998. The price had an obvious upward before the Asian financial crisis and it reached at 101.87 in October 1997, increasing fourfold than three years ago, which is the largest growth rate. The Chinese liquidity has been a key driver of fine wine market price (*Financial Times*, 2017). According to National Bureau of Statistics, the average

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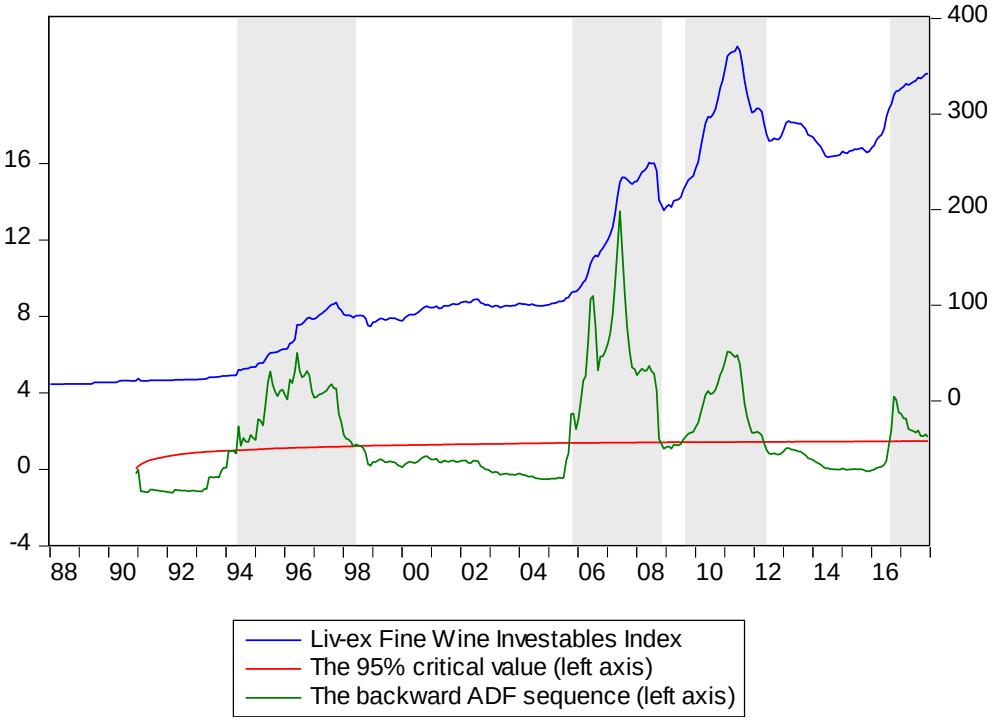
supply of broad money (M2) was $ 9062.36 billion during this period, an increase of 24.28% compared with the previous year, and the narrow money (M1) supply was $3508.24 million, an increase of 18.06%. And due to the lag effect of money supply, this bubble lasts for forty-seven months, the longest in the sample period. However, the Asian currency crashed in 1997 and the depreciation led to an increase in the purchasing cost of wine. With the weakening currency, the demand for fine wine from Asia was decreased and the price fell by 24.5%, which were at a low level compared to previous years. Finally, the bubble burst due to the Asian financial crisis.



Note: the shadow areas are sub-periods with bubbles.

Figure 1: The GSADF tests of the null hypothesis of a unit root against the alternative of an explosive root in the fine wine market.

In August 2005, we detect the second bubble, which collapsed in August 2008. Figure 1 indicates that the fine wine market price jumped from 106.58 to 244.77, the huge rising range since the 2000s. The subprime crisis breaks out followed by

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the bubble burst. Cevik and Sedik (2011) argue that fine wine prices are sensitive to macroeconomic shocks, just like crude oil and other commodity price. During this period, the U.S. authorities adopt low-interest rates to reverse the "double deficit" and reduce the interest rate ten frequency: there are three times in 2007 and seven times in 2008. It causes the depreciation of the U.S. dollar during this period and Jiao (2016) indicates that the continuous depreciation of the dollar drives up the fine wine prices. Jiao (2016) also claims that fine wine price soared since the first half of the 2000s due to the considerable demand from the emerging market. According to the National Bureau of Statistics, China has an average 12% growth rate of GDP from 2005-2008. This economic boom has created new wealth in China, which produced a huge demand for fine wine. Moreover, in order to fulfill the World Trade Organization (WTO) commitments, China reduced the tax rate of more than 900 tax items in 2005, and the import tariff on wine was lowered from 44.6% to 14%. Therefore, the demand in China for wine is further released. In addition, Jiao (2016) notes that the fine wine price skyrocketed also due to speculation in the secondary market where consumers or investors provide considerable demand. The number of put options will less than the number of call options when speculators seek to take positions in commodity futures contracts for profit. This result pushes up the futures prices and also the price of related spot commodity themselves. However, the subprime crisis broke out in 2008 caused the most severe recession and the global economy is heavily affected, causing the sharp decline in wine demand. For example, influenced by this crisis, China's GDP growth rate in 2008 was 9.7%, a decrease of 31.7% compared with 14.2% in 2007, which led to the demand from domestic decline. Therefore, the growth trend of fine wine price in previous years can't continue and last the bubble burst.

The third bubble appeared in August 2009 and burst at the end of May 2012. The reason for this bubble is the same as the last one. During this period, Figure 1 shows that the fine wine market price skyrocketed in a row and hit 369.81 in June 2011, reached its highest level. After the subprime crisis, the Federal Reserve (Fed) in the U.S. implemented quantitative easing (QE) policies to cope with the impact of the crisis. The Fed implemented this measure three frequency in 2008, two times

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in 2010. The low interest-rate causes the capital to escape from the U.S., leading to a decline in the value of the dollar. The depreciation of the dollar can increase the purchasing power of foreign consumers, then the demand for fine wines has expanded and the price in this market has increased (Jiao, 2016). Moreover, Fernandez *et al*. (2016) indicate that investors are increasingly expressing an interest in alternative investments after the subprime crisis, such as fine wine. They can be a safe investment during the turmoil period considering the hedging capability (Bouri, 2015), which is different from world major equities. Therefore, numerous investors perceived this segment as a safe haven for their funds and the global world demand for the fine wine continued to grow. The considerable increase in demand for wine, notably from Asia, since the subprime crisis has enhanced the price momentum (Fernandez *et al*., 2016). Cardebat and Jiao (2018) also argue that the increasing demand from emerging markets, notably in China, increase the price of fine wines. According to Organisation Internationale de la Vigne et du Vin (OIV), the production of the wine in the world decreased 0.5% from 2008 to 2011 while wine consumption in China increased 16.52% and the imports increased 104%. Therefore, the gap between the massive demand and scant supply-side form emerging economy push the wine price up to and form a bubble. However, the cooling of economic growth in emerging economies and the decline in the value of currencies since 2011 has generated negative influence on this market (Jiao, 2016) and fine wine prices have been experiencing a sharp decrease after the peak at 2011. The growth rate of China's GDP was 9.5% and 7.9% in 2011 and 2012, respectively, a very large decrease. Therefore, the slowdown of China's economy cut back the demand for wine. Other unpredictable factors such as anti-corruption actions initiated by President Xi Jinping in China also contribute to the reducing demand.

The last bubble occurred on April 2016. The fine wine market price increased from 275.42 in April 2016 and soared to 341.28 on December 2017, which is near to the peak at 2011. Bordeaux Index shows that fine wine sales hit £50 million in the first six months of 2017, up 43% compared to the same period in 2016. With this substantial increase in the demand, we observe the start of explosive behavior

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in the fine wine market, which suggests that it is currently in the mania phase of a speculative bubble's formation. In addition, the uncertainty surrounding the economic environment recently cannot be neglected and a new politic event might alter the status of supply or demand in fine wine markets (Jiao, 2016), such as the Trump election and the Brexit. According to Wine and Spirit Trade Association Market Report 2017, the impact of Brexit, which saw the value of the pound plummet, led to a 3% increase on wine prices in 12 weeks to the beginning of 2017. Further, the Brexit has created some good buying opportunities for non-sterling based investors (*Financial Times*, 2016). The pound exchange rate plunging led to increased purchasing power for fine wine in the emerging economies, which produced a considerable demand for fine wine. Therefore, the fine wine market price continues to soar and the bubble has not yet burst.

Several suggestions on stabilizing the fine wine price and the possibility of the bubble burst should be noticed, especially in recent years when the bubble is still in the formation stage, which has not burst. First, the speculative money from investment funds makes the price of wine distorted, which strengthens market instability. Thus, authorities should regulate the operation of fine wine investment funds in this market. Second, since the fluctuation of the U.S. dollar is crucial to the fine wine price (Jiao, 2016), the traders and investors should pay close attention to changes in dollar exchange rates in the international market. Finally, due to the emergence of new alternative investment, the global demand for fine wine increases enormously, notably from China, which pushes up the fine wine price straightly. Therefore, the government should manage public anticipation and avoid irrational investment. Furthermore, we enforce appropriate policies to reduce the negative impact of the bursting of the fine wine price bubble.

6. Conclusions

In this study, we investigate the existence of bubbles in the fine wine market from 1988 to 2017, applying the GSADF test developed by Phillips *et al*., (2012, 2013). The empirical findings suggest that multiple bubbles exist in this market in 1994:05-1998:04; 2005:08-2008:08; 2009:08-2012:05 and 2016:04-Now. The emergence of bubbles corresponds to the period of rising prices; on the contrary,

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the price decline will lead to the bursting of the bubble, which is in agreement with the bubble model (Gürkaynak, 2008). We notice that the bubbles in the fine wine market mainly appear during the fluctuations of the market price. This phenomenon is mainly related to the increased demand, the weakening of the U.S. dollar and the other unpredictable factors. The evidence from this paper could be beneficial to investors and regulators in the fine wine market, whose investment strategy and policy implementation will depend on understanding the dynamics and behavior of their prices over time. Here are some implications. First, the speculative behavior in the fine wine market distorts prices, exacerbates instability and leads to bubble formation, which cannot stabilize the development of this market. Therefore, policymakers are forced to identify any bubble in early stage in order to avoid the next bubble burst in the future and stabilize the environment of the fine wine market. Second, due to the emergence of wine investment, the increasing demand for fine wine pushes the price of wine. When the fine wine investment is overheated, it is in the mania phase of a speculative bubble's formation. Thus, the authorities should manage public anticipation and avoid irrational investment to stabilize this market. Moreover, the subprime crisis has an influence on the wine market, therefore, the government should prevent spillover effects of foreign financial risks. Finally, changes in the US dollar exchange rate is crucial to the fine wine pricing (Jiao, 2016). Therefore, market traders and investors should pay close attention to their fluctuations and mitigate negative shocks.

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