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Detecting Financial Bubbles Using Gap between Common Stocks and Preferred Stocks

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Abstract**—**How to detecting financial bubble? Addressing this simple question has been the focus of a vast amount of empirical research spanning almost half a century. However, financial bubble is hard to observe and varying over the time; there needs to be more research on this area. In this paper, we used abnormal difference between common stocks price and those preferred stocks price to explain financial bubble. First, we proposed the 'W-index' which indicates spread between common stocks and those preferred stocks in stock market. Second, to prove that this 'W-index' is valid for measuring financial bubble, we showed that there is an inverse relationship between this 'W-index' and S&P500 rate of return. Specifically, our hypothesis is that when 'W-index' is comparably higher than other periods, financial bubbles are added up in stock market and vice versa; according to our hypothesis, if investors made long term investments when 'W-index' is high, they would have negative rate of return; however, if investors made long term investments when 'W-index' is low, they would have positive rate of return. By comparing correlation values and adjusted R-squared values of between W-index and S&P500 return, VIX index and S&P500 return, and TED index and S&P500 return, we showed only W-index has significant relationship between S&P500 rate of return. In addition, we figured out how long investors should hold their investment position regard the effect of financial bubble. Using this W-index, investors could measure financial bubble in the market and invest with low risk.

Keywords**—**Financial bubbles, detection, preferred stocks, pairs trading, future return, forecast.

I. Introduction

EVERY time after the global financial crisis, detecting financial bubble was an intriguing topic for many researchers. Even though each researcher who has different background knowledge tries to solve this problem in different aspects, one could not satisfy with results because the detecting financial bubble requires complicated mathematical knowledge, and effects of bubble in stock prices could not be distinguished easily from the effects of unobservable market fundamentals; therefore, this problem stays for a long time. Similar to the other aftermath's financial crisis, experiencing 2007-2008 financial crises, not only practicing companies but also academic fields realized that there should be more research on financial bubbles. They believed if there was valid financial bubble detector before financial crisis, people could have prevented that incident. What they want is the accurate financial bubble detector that is easily understandable for normal people and that is able to forecast future financial crisis.

There has been a lot of research paper on financial bubble. Following researchers commonly emphasized that financial bubble is extra price added to fundamental value. Garber defined financial bubble as the part of the price movement that cannot be explained by fundamentals [1]. Kindelberger and Aliber defined bubble as an upward price movement over an extended range that then implodes [2]. Brunnermeier argued that bubbles are typically associated with dramatic asset price increases followed by a collapse [3]. Wu defined bubbles as the difference between the fundamental value and the market price allowing [4]. On the other hand, there are many researchers who define and improve the financial bubble detections. Shiller [5] and LeRoy and Porter [6] used variance bound test to pricing the equity. In addition, Blanchard and Watson [7] and Tirole [8] developed this variance bound test to detect financial bubble. Although this variance bound test to detect financial bubble is criticized by other researchers, they are the first people to try detecting financial bubble. Diba and Grossman tried to explain the theoretical properties of bubbles [9]. Recently, Phillips et al. used the unit root behavior of key fundamental financial variables to detect bubble in 2008 subprime mortgage [10].

Unlike the previous studies, we focused on fundamental theory that people would lose money if they invest when there is financial bubble and gain money if they invest when there is comparably low financial bubble. In this study, we got the idea of detecting financial bubbles from pairs trading and preferred stocks. Gatev et al. showed that pairs trading is actually worked in financial market [11]. Pairs trading is a market neutral trading strategy that use two stocks that have been move similarly; after that when two stocks are diverging buy undervalued stocks and sell overvalued one and wait until the mispricing will correct itself in the future [11]. Instead of using two similar stocks, we used common stocks and its preferred stocks to find a spread and using this spread we build 'W-index' which indicates the spread between common stocks and preferred stocks in market.

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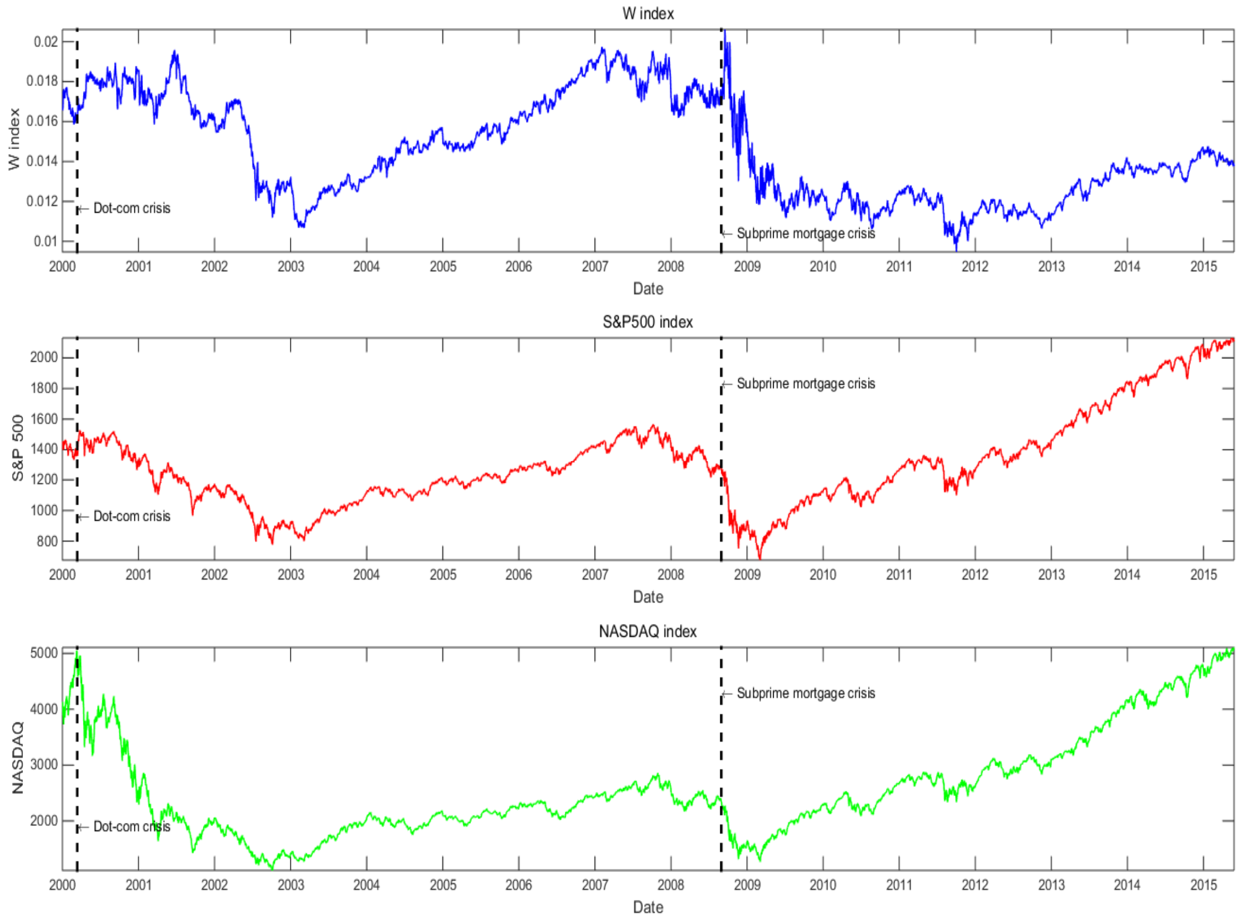

Fig. 1 Plots of w-index, S&P500, NASDAQ and financial crisis

We believe that the abnormal difference between common stocks price and those preferred stocks price in stock market could explain financial bubbles because the prices of common stock and its preferred stock come from the same company; therefore, the difference should be explained by historic data if the bubble does not exist. If the gap cannot be explained by historic data, we can suspect that investors overvalued common stocks comparing to its preferred stocks and this could be an evidence of financial bubble in the market. First, we build W-index that indicates gap between common stocks and those preferred stocks in financial market. Second, we showed that there is a relationship between this W-index and S&P500 future return. In the other words, we showed that when W-index is high, the future return is low, and when W-index is low, the future return is high; therefore, they have strong negative relationship. To support this relationship, we compare correlation values and adjusted R-squared values of W-index and S&P500 future return, VIX index and S&P500 future return, and TED index and S&P500 future return, we show that there is a strong relationship between W-index and S&P500 future return. Lastly, we figure out the duration time of financial bubble to be generated and to be burst by comparing correlation and R-squared value between W and various i month future return.

II. Data

Thomson Reuters Datastream provides time series data of common stocks' closed price and its preferred stocks' closed price from January 1st 2000 to May 31st 2014 that is in NYSE (New York stock exchange). In addition, we also get index time series data such as S&P500, NASDAQ, and KOSPI200 from Datastream. There are 168 pairs of common stocks and its preferred stocks, and there are 3875 trading dates.

III. Method

Step 1. Construct market spread between common stock and its preferred stock.

Let C_t^i be the observed price of common stock i at time t and $c_t^i = \ln(C_t^i)$ be the corresponding log price. On the other hand, let P_t^i be the observed price of preferred stock i at time t and $p_t^i = \ln(P_t^i)$ be the corresponding log price.

According to arbitrage pricing theory in finance, if two stocks have similar characteristics, then the prices of both stocks must be more or less the same. Therefore, in this case, since c^i and p^i are sharing same company's financial statement, c^i and p^i are likely to be driven by a common component and are co-integrated. Using simple linear regression, we set up

$$c_t^i = \beta_0 + \beta_1 p_t^i + w_t^i . \quad (1)$$

Rewriting this equation, we get

$$w_t^i = c_t^i - \beta_1 p_t^i - \beta_0. \quad (2)$$

where w_{it} as the spread between the i^{th} common stock log price and i^{th} preferred stock log price at time t. To build market index that shows spread between common stocks and its preferred stocks, we calculated each spread of 168 common stocks and its preferred stocks from January 1st 2000 to May 31st 2015 and average them.

$$W_t = \frac{\sum_{i=1}^{168} w_t^i}{N_t} \quad t = 1,2, \ldots \ldots 3875 \quad (3)$$

where W_t is the average of w_{it} that available at time t, and N_t is the number of pairs that alive at time t.

Step 2. Find relationship between W_t and future return.

$$r_{it} = \frac{s_{t+i} - s_t}{s_t} \quad \mathrm{i} = 1,2, \ldots \ldots 48 \quad (4)$$

where r_{it} is i month future return on S&P500, assuming investors buy S&P500 index at time t and sell at $\mathrm{t} + \mathrm{i} * 20$, s_{t+i} is the S&P500 index at time $\mathrm{t} + \mathrm{i} * 20$, s_t is the S&P500 index at time t.

$$corr_i = \frac{\Sigma(W_t * r_{it}) - \Sigma(W_t) * \Sigma(r_{it})}{\sqrt{[\Sigma W_t{}^2 - (\Sigma(W_t))^2] * [\Sigma r_{it}{}^2 - (\Sigma(r_{it}))^2]}} \quad \mathrm{i} = 1,2, \ldots \ldots 48 \quad (5)$$

where $corr_i$ is correlation between W and r_i. For instance, $corr_{12}$ indicates correlation between W and 12-month future return. Using $corr_i$, we will show there is negative correlation between W and r_i and which i makes $corr_i$ significant. The number of trading dates is varying because to pair with W and i month future rate of return, we can only use $3875 - \mathrm{i} * 20$ days.

Our hypothesis is that when W_t is high, there is large amount of financial bubble in stock market; on the other hand, when W_t is low, there is small amount of financial bubble in stock market. To test this hypothesis, we used return of S&P500 index. Our test is simple; according to our hypothesis, investors would have negative rate of return if they buy stocks when W_t is high; however, investors would have positive rate of return if they buy stocks when W_t is low. Therefore, we used adjusted R-squared and correlation method to find relationship between W_t and r_{it} to prove our hypothesis. In addition, we used from 1 to 48-month rate of returns to find out the relationship between i month future return and W_t. In more detail, 1-month future return is buy S&P500 index at time t and sell next month; similarly, 36-month future return works likewise. Moreover, to show that W-index could explain financial bubble and future return better than the other common risk measures, we compared with VIX and TED. VIX is a volatility index that used to measure sensitivity to market change, which reflects market liquidity. It derived from settlement and implied market volatility of two different time points. TED is spread between T-Bill and Eurodollar that used to measure credit risk.

Step 3. Find relationship between W_t and future return when W_t is lower or higher than certain points.

To test our hypothesis, it is important to find out what happen to r_{it} when W_t is low and W_t is high. This is because when investors actually using this W-index, they would consider low W_t periods as a long position opportunity and high W_t periods as a short position opportunity. Therefore, we select W_t that is bigger or less than 1.5 standard deviation from mean of W. After composing this sample, we select r_{it} that corresponds to selected W_t. Using this selected W_t and r_{it}, we get correlation and r-squared value for each i month. We applied the same way to VIX index and TED index to compare with W-index.

IV. Empirical Result

In this section, we test our hypothesis using data from New York Stock Exchange. First, we set up the W-index over January 1st 2000 to May 31st 2015, and the checked W-index was high before the market crashes and low before the market is recovered. Especially, we will show what was happened in W-index around Dot-com crisis, and Subprime mortgage crisis. Second, we set up the r_{it} for $(3875 - 20\mathrm{i})$ days; we used i from 1-month to 48-month. Matching these r_{it} with W by dates, we draw four scatter plots to visualize the relationship between W and i month future return. In addition, to be more specific for their relationship, we built regression equation between W and r_{it}. Third, we calculated correlation and R-squared value of W and r_{it}, VIX and r_{it}, TED and r_{it} for i from 1 month to 48-month to compare the relationship between W and i month future return, VIX and i month future return, and TED i month future return. During this process, we try to find if there is any relationship between correlation of W and r_{it} with varying i month. Lastly, out of 3875 dates, we select the dates that has W with higher or lower than 1.5 standard deviation away from the mean of W. After that, we find correlation and adjusted R-squared value between W and r_{it} because we believed that it is important to figure out what happened to the market when W is higher than certain points or lower than certain points. To find out what happened to market when VIX index and TED index got higher or lower than certain points, we applied the same process on VIX index and TED index that we did in W index.

In Fig. 1, this shows W-index, S&P500 index, and NASDAQ index from January 1st 2000 to May 30th 2015 and dashed line of financial crises. There are 3875 dots in each graph which indicate available trading dates. According to Fig. 1, we can infer that before the both S&P500 and NASDAQ index are heading downward when the value of W-index is relatively higher than other periods. Similarly, when the value of W-index is relatively low, both S&P500 and NASDAQ index are heading upward. The first dashed line indicates Dot-com crisis in 2000, and the second dashed line indicates Subprime mortgage crisis in 2008. In both crises, not only W-index gets higher before crises but also W-index stays relative high until both S&P 500 and NADAQ index touch the bottom. From Fig. 1, we can infer that the crises do not necessarily occur when the value of W is the highest; however, before the crises, relatively high value of W continuously bring cautious to the market about financial bubble in the market. We believe that because there is financial bubble in the market, the negative affecting event could trigger the financial crisis. Furthermore, to check more detailed relationship between W-index and i month future return, we draw scatter plot of W and i month future return of trading dates' dots in Fig. 2.

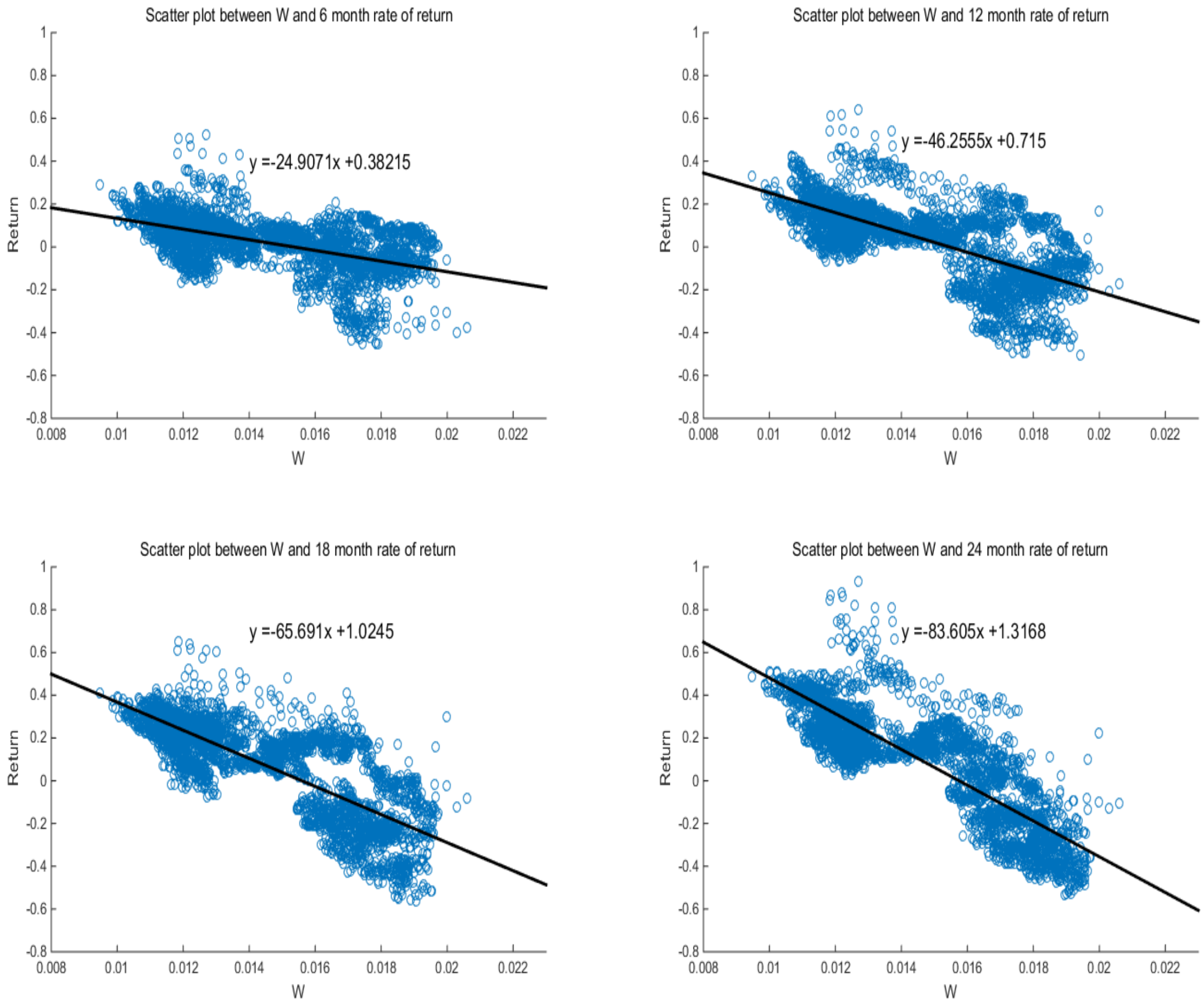

Fig. 2 Scatter plot of W and 6, 12, 18, 24-month future return

In Fig. 2, we draw scatter plot of w and 6, 12, 18, 24-month future return and draw a linear regression line. As explained in earlier, there are 3755 dots in 6-month scatter plot; there are 3635 dots in 6-month scatter plot; there are 3515 dots in 18-month scatter plot; there are 3395 dots in 24-month scatter plot. According to Fig. 2, it is clear that as i increases, the relationship between W and i month future return gets better. In addition, according to b_1(slope for the regression line) for each regression line indicates that there is negative relationship between W and i month future return. In more detail, slope of each regression line gets deeper as i increases. This supports our hypothesis that when W is high there is large amount of bubbles in the market, and when W is low there is small amount of bubbles in the market, the underlying idea about our hypothesis is as follows. When people invest in market during large amount of financial bubble periods, it is unlikely to have negative rate of return in short period but most likely to have negative rate of return in long period; similarly, when people invest during small amount of financial bubble periods, it is unlikely to have positive rate of return in short period but most likely to have positive rate of return in long period. This is because financial bubble does not build or collapse in short period of time; it takes some time to build or collapse. In the other words, comparing correlation and adjusted R-squared value between W-index and various i month future return, it is possible to find out time duration to build and to collapse of financial bubble. On the other hand, it is important to compare correlation and adjusted R-squared value of W and i month future return with other correlation and adjusted R-squared value of other volatility index and i month future return since if correlation and adjusted R-squared value of other volatility index and i month future return is higher than those of W and i month future return, investors would use existed volatility indexes instead of using W-index. To show that not only there is stronger relationship as i month future return gets bigger, but also W-index is more reasonable to predict i month future return and detect financial bubble than the other existing volatility indexes, in Fig. 3, we compare correlation and adjusted R-squared value between W and i month future return, VIX and i month future return and TED and i month future return.

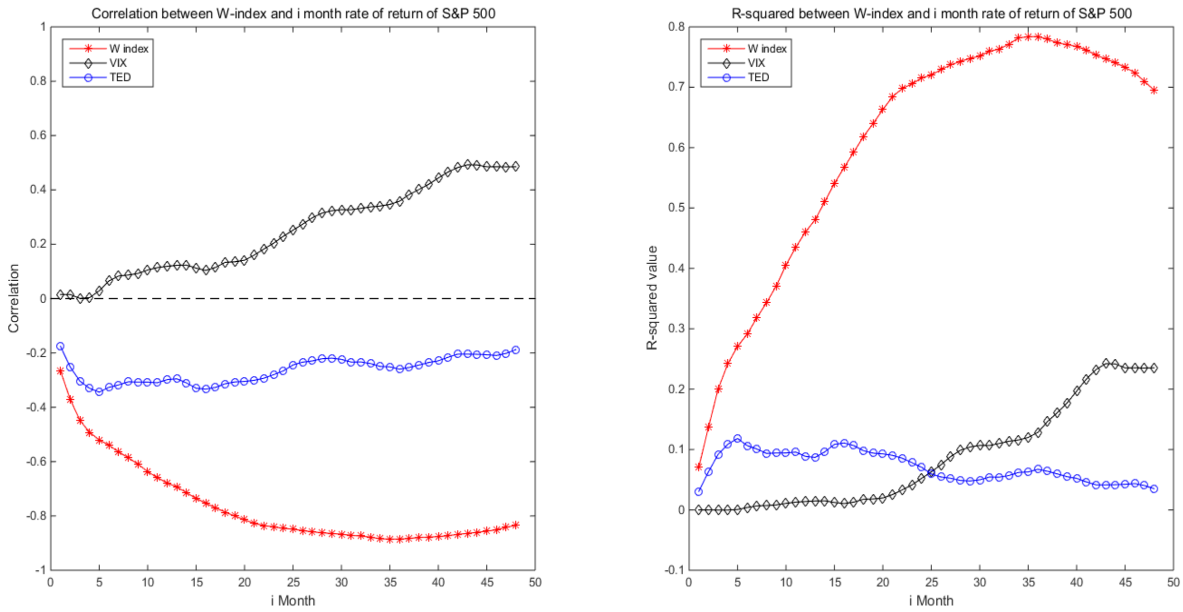

Fig. 3 Correlation and adjusted R squared value of W with varying i month future return

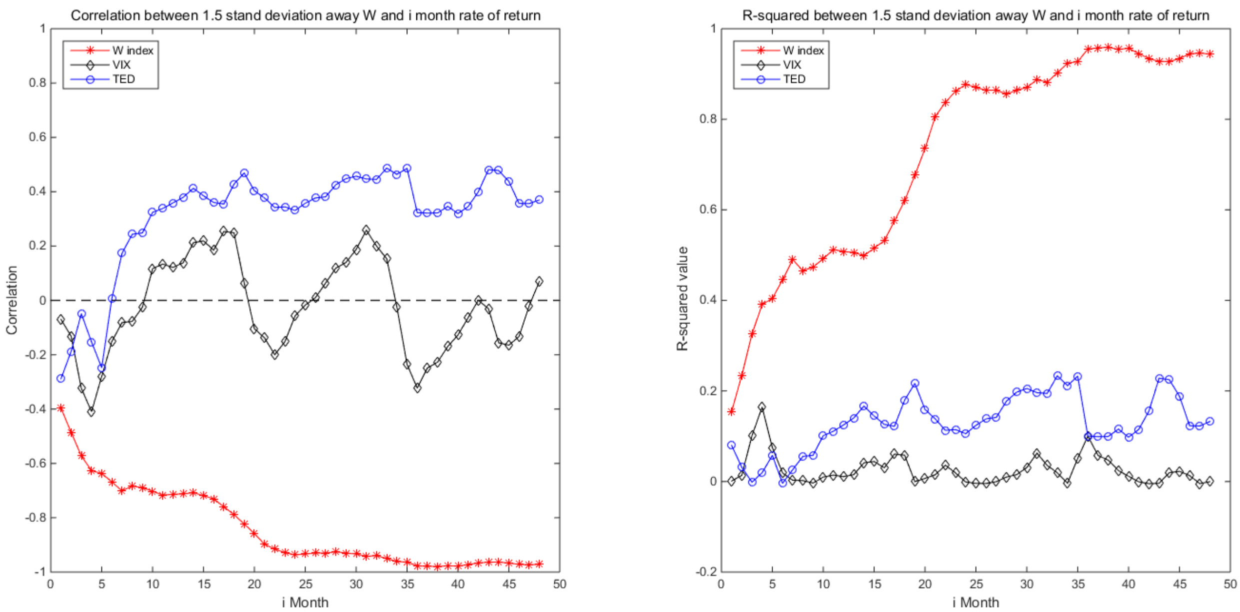

Fig. 4 Correlation and adjusted R squared value of 1.5std away W with varying i month future return

The first picture in Fig. 3 shows correlation values of W and i month future return, VIX and i month future return, TED and i month future return. According to this picture, W index line starts around -0.2 and ends up around -0.8; however, VIX line starts around 0 and ends up around 0.5; TED line starts around -0.2 and ends up around -0.2. From this observation, it is clear that W index has the better relationship with i month future return than those of VIX and TED. In addition, it is clearly shows that as i gets bigger, the relationship between W and i month future return gets stronger. In more detail, according to this result, we can think that our hypothesis is correct since W and i month future returns have strong negative relationship, which means when W is high, the i month future return will be low, and when W is low, the i month future return will be high. On the other hand, this result is very important because according to the second picture of Fig. 3, it shows that adjusted R-squared value of W index line starts around 0.1 and highest around 0.8; however, VIX line starts around 0 and highest around 0.2; TED line starts around 0 highest around 0.1. Similar to previous result, using W index would be more reasonable if investor wants to use index that could explain future return. In addition, R-squared between W_t and r_{it} is bigger than 0.7 when i is bigger than 20, which means people can use today's W-index to predict 2-year rate of return with 0.8 R-squared value. According to these results, people should take long position when W is low and take short position when W is high, and this works better if they invest in long periods than those of short periods. In addition, the R-squared value is rapidly increasing until i is 21 and slowly increasing until i is 36 and starts decreasing. From this observation, it can be inferred that duration time of financial bubble to be generated and to be burst is around 24 months to 36 months.

In Fig. 4, we use the selected dates that contain W bigger or less than 1.5 standard deviation away from the mean of W and matched with corresponding r_{it}. We apply the same way to VIX, and TED indices. With those selected dates, we calculated correlation value and adjusted R-squared value. According to the first picture of Fig. 4, 1.5 standard deviation away W has strong negative correlation with i month rate of return; 1.5 standard deviation away TED index line has mediocre positive correlation with i month future return; 1.5 standard deviation away VIX index has no meaningful correlation i month future return. The second picture of Fig. 4 shows only 1.5 standard deviation away W has only meaningful adjusted R-squared value. Similar to Fig. 3, both correlation value and adjusted R-squared value increase rapidly until i is 21 and slowly increasing after that. From this result, it is possible to think that if investors wait until the W index gets lower or higher than certain points and invest in that period and hold for two years, they are mostly likely to have high rate of return. Table I summarizes the data that are used in Fig. 3, and Table II summarized the data that are used in Fig. 4.

TABLE I
SUMMARY OF RELATIONSHIP BETWEEN r_{it} AND W, VIX, AND TED

	Using all W					Using all VIX					Using all TED				
i	Corr	R^2	B_0	B_1	T	Corr	R^2	B_0	B_1	T	Corr	R^2	B_0	B_1	T
3	-0.448	0.200	0.211	-13.847	3815	0.001	0.000	0.009	0.000	3815	-0.304	0.092	0.034	-0.054	3815
6	-0.540	0.291	0.382	-24.907	3755	0.065	0.004	0.002	0.001	3755	-0.327	0.106	0.059	-0.086	3755
9	-0.609	0.371	0.548	-35.594	3695	0.093	0.008	-0.003	0.002	3695	-0.307	0.094	0.077	-0.103	3695
12	-0.679	0.460	0.715	-46.256	3635	0.119	0.014	-0.009	0.002	3635	-0.298	0.089	0.094	-0.116	3635
15	-0.736	0.541	0.866	-55.774	3575	0.112	0.012	-0.001	0.002	3575	-0.330	0.109	0.119	-0.144	3575
18	-0.786	0.618	1.025	-65.691	3515	0.133	0.018	-0.005	0.003	3515	-0.314	0.098	0.136	-0.151	3515
21	-0.827	0.684	1.185	-75.724	3455	0.160	0.025	-0.015	0.004	3455	-0.301	0.090	0.153	-0.159	3455
24	-0.846	0.715	1.317	-83.605	3395	0.229	0.052	-0.053	0.007	3395	-0.266	0.071	0.164	-0.151	3395
27	-0.859	0.737	1.432	-90.367	3335	0.298	0.088	-0.097	0.009	3335	-0.229	0.052	0.170	-0.139	3335
30	-0.867	0.752	1.517	-95.122	3275	0.327	0.107	-0.117	0.010	3275	-0.224	0.050	0.182	-0.140	3275
33	-0.878	0.771	1.597	-99.409	3215	0.337	0.114	-0.118	0.011	3215	-0.239	0.057	0.199	-0.152	3215
36	-0.886	0.784	1.690	-104.309	3155	0.359	0.128	-0.129	0.012	3155	-0.260	0.067	0.222	-0.169	3155
39	-0.878	0.771	1.766	-108.153	3095	0.421	0.177	-0.173	0.014	3095	-0.235	0.055	0.228	-0.158	3095
42	-0.868	0.753	1.825	-110.761	3035	0.482	0.232	-0.217	0.017	3035	-0.204	0.042	0.233	-0.140	3035
45	-0.856	0.733	1.895	-114.196	2975	0.485	0.235	-0.218	0.018	2975	-0.207	0.042	0.245	-0.145	2975
48	-0.834	0.695	1.964	-117.482	2915	0.485	0.235	-0.223	0.018	2915	-0.188	0.035	0.248	-0.135	2915

TABLE II
SUMMARY OF RELATIONSHIP BETWEEN r_{it} AND 1.5 STANDARD DEVIATION AWAY W, VIX, AND TED

	1.5 standard deviation away W					Using 1.5 standard deviation away VIX					1.5 standard deviation away TED				
i	Corr	R^2	B_0	B_1	T	Corr	R^2	B_0	B_1	T	Corr	R^2	B_0	B_1	T
3	-0.572	0.326	0.265	-16.094	369	-0.324	0.101	0.201	-0.004	265	-0.049	-0.002	-0.078	-0.007	257
6	-0.668	0.445	0.450	-25.579	350	-0.151	0.019	0.204	-0.002	263	0.008	-0.004	-0.125	0.002	247
9	-0.689	0.474	0.451	-27.063	336	-0.025	-0.003	0.190	0.000	257	0.248	0.058	-0.255	0.064	247
12	-0.714	0.508	0.616	-38.712	319	0.122	0.011	0.144	0.002	252	0.359	0.125	-0.392	0.126	242
15	-0.719	0.515	0.692	-45.845	304	0.219	0.044	0.104	0.003	250	0.385	0.145	-0.462	0.154	237
18	-0.788	0.620	0.938	-61.115	287	0.249	0.058	0.115	0.004	244	0.428	0.180	-0.479	0.178	233
21	-0.898	0.806	1.194	-78.081	271	-0.138	0.015	0.425	-0.002	239	0.377	0.138	-0.368	0.126	228
24	-0.937	0.877	1.332	-87.506	257	-0.057	-0.001	0.444	-0.001	235	0.331	0.106	-0.308	0.119	226
27	-0.930	0.865	1.467	-93.278	249	0.064	0.000	0.411	0.001	230	0.381	0.142	-0.334	0.160	221
30	-0.933	0.870	1.480	-90.316	239	0.187	0.031	0.349	0.003	228	0.457	0.205	-0.382	0.202	221
33	-0.950	0.903	1.521	-90.202	249	0.154	0.019	0.350	0.002	223	0.487	0.234	-0.366	0.197	219
36	-0.977	0.955	1.622	-94.651	253	-0.323	0.100	0.758	-0.006	220	0.323	0.100	-0.217	0.111	218
39	-0.977	0.954	1.682	-96.971	260	-0.170	0.024	0.696	-0.003	214	0.346	0.116	-0.193	0.124	215
42	-0.966	0.934	1.717	-97.912	268	0.000	-0.005	0.586	0.000	210	0.400	0.156	-0.224	0.167	213
45	-0.967	0.934	1.763	-98.657	254	-0.165	0.023	0.774	-0.003	210	0.438	0.188	-0.241	0.172	209
48	-0.972	0.944	1.840	-100.900	240	0.070	0.000	0.566	0.001	195	0.370	0.133	-0.212	0.169	208

V. Conclusion

This paper has shown that gap between common stocks and those preferred stocks could be used to detect financial bubble. We reach several conclusions. First, using individual pairs of common stocks and preferred stocks, we could build 'W-index' that indicates the gap between common stocks and those preferred stocks in market. Using this index, we tested whether this W-index could detect financial bubble by finding relationship between W-index and future rate of return. Second, we showed that there is strong negative relationship between W-index and future return, and this relationship is more reasonable than relationship between VIX and future return, and relationship between TED and future return. Third, calculating correlation and adjusted R-squared value of W and future return, we showed that there is stronger relationship when the period of future return is longer than two years. From this result, we can think that build and collapse duration time for bubble is around two to three years. Last, we showed that when W-index in higher or lower than 1.5 standard deviation away from the mean of W, it is a great opportunity to make an investment. For instance, if W is higher than 1.5 standard deviation away from the mean of W, investor should take short position and vice versa. This paper has built W-index that has very significant correlation and adjusted R-squared value with long term future return. This is very difficult because considering current volatility index could not explain any of future return, and it is hard to predict what will happen in the future.

There are some limits on this paper. We believe that the period should be longer. In our research, there were only two financial crises; in our case, due to the limited time and resources, data from 2000 to 2015 were the most accurate data that we could get. However, in further research, we will get a longer period to validate W-index. In addition, we need more research on making more accurate W-index than this one.

Further research could focus on adapting W-index in the other markets such as Europe or China; we did try on Korea stock market but did not work well. On the other hand, build long term investment portfolio using W-index and comparing to the other portfolio would be an interesting topic to research. In addition, it is possible to research on long term investment strategy using W-index.

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