A Possible Method for Warning of House Price Bubble

ABSTRACT

Metropolitan areas that had the most house price inflation between 1998 and 2006 and the highest price to income ratios are characterized by strong income growth and high population density. Areas with the highest price to income ratios in 2006 and lowest population density suffered the largest percentage price declines after the bubble burst. An equation is established for estimating warning level against house price bubble, and the estimated warning could leave 19 percent room and more than two years of time for action.

Key Words: method, warning, house price bubble

Introduction

There has been increasing interest in the movements of house prices after the U.S. house price bubble resulted in the worst financial crisis and the severest recession since the great depression and brought tremendous damages to America and the world. The most important and intriguing subject is whether a bubble is predictable and avoidable. Thus, it challenges researchers to find a possible way to warn people of a forming house price bubble although Alan Greenspan once said in 2008 "we can tell a bubble only after it burst."

It is extremely difficult, if not impossible to tell whether house prices have increased too rapidly or are too high so that a bubble is growing, and there is no ideal method that is generally agreed upon for forecasting a bubble either. Even though, investors have been trying desperately to detect signals for a house price bubble and the price level at which the bubble will burst, in order to manage risk and reap super profit. Governments have also become very careful about the issue after being astonished by the huge damages caused by the real estate price bubble in Japan and the United States.

Shiller (2006) is one of the most strong to have alerted people about the house price bubble in the Unites States. Comparing the movement and level of rent-to-price (R/P) ratio with real interest rates and stock dividends, he concludes that house prices are excessive in 2005. He points out that the rent-to-price ratio has trended downward from 1913 to 1995, the decline has been very gradual but then became steeper since 1995 and is too low. On the contrary, Smith and Smith (2006) show that R/P levels at the time are overly high. They argue that rental levels are not comparable to price levels, because, in addition to yards, sizes of apartments and houses are greatly different and these characteristics have changed over time. Himmelberg, Mayer and Sinai (HMS, 2005) point out that the movements in prices have almost perfectly matched the movements in real interest rates and incomes since 1976.

There are numerous papers in the literature on forecasting house prices, and on analyzing factors that may affect house price movements. Capozza, Hendershott and Mack (CHM, 2004) summarized that people generally believe that house prices and rents should rise as income, employment and population increase. But quite often, the forecasting models produce wrong signs of the coefficients on economic fundamentals (Wheaton and Nechayev, 2008). Researchers report conflicting evidences on the relationship between house price and economic fundamentals, Abraham and Hendershott (1996), Capozza et al (2002), Malpezzi (1999) find evidence for cointegration between home prices and fundamentals, Attanasio et al (2012) find higher income leads to greater home ownership, whereas Poterba, Wei and Shiller (1991), Meen (2002), and Gallin (2006) report evidence against cointegration. Recently, Zhou (2010) finds evidence of nonlinear cointegration relationship between house prices and economic fundamentals in some cities but does not find any relationship in the largest cities, Boston, Los Angeles and New York.

Wheaton and Nechayev (2008) reveal that the degree of the excess price increase between 1998 and 2006 is related to widespread availability of subprime mortgage credit and prevalent second home and speculative purchase. Mian and Sufi (2008) also show that increasing access to credit pushed up housing prices from 2000 to 2005. In contrast, Goetzmann, Peng, and Yen (2012) notice that house prices in some areas were rising ahead of the widespread access to credit by subprime borrowers.

In this study we examine the rapid inflation in house prices from the end of 1998 to the summer of 2006 and the collapse of house prices from the summer of 2006 to early 2009, and investigate the factors that may explain the wide differences among levels of price inflation during the formation of the bubble and price deflation after the burst of the bubble in major U.S. metropolitan areas. The key purposes of this study is to find some indicator that may signal the formation of a house price bubble, and establish a method that may estimate some warning level of the indicator at which investors should reduce or hedge their positions and government should take actions to cool off the market.

The house price index (conventional mortgage home price Index, CMHPI) is published by Freddie Mac, data of population, density and per capita income is published by the U.S. Census Bureau, the density data is available for years 2000 and 2010, the unavailability of annual density data should not affect this study as metropolitan population changes are relatively small and smooth, and each metro area's relative density is about stable. Income data is available annually. We select the twenty metropolitan areas, names of the principal cities of the areas are the same as these in the Case-Shiller 20 city House Price Index, because they are the most representative in the nation. We prefer to use metropolitan area data because it better represents the whole market of interest as many people work in the principal city but live in suburbs and smaller cities surrounding the principal city. The personal saving rate data is published by the Bureau of Economic Analysis.

Movements of the U.S. house prices and price to income ratios in the period

House price inflation in major U.S. metropolitan areas started to accelerate since late 1998, peaked around the summer of 2006, then the bubble burst and prices collapsed. The price precipitation continued for almost three years, the rate of decline abated for a couple of months in the late stage of price declines, finally some metro areas saw prices crawl up in the spring of 2009 for several months. Then house prices fluctuated for several months and then drifted down for almost three years until early 2012.

The magnitudes and timing of house price inflation and crash are significantly different among the metropolitan areas. A descriptive statistics of the price changes is provided in Table 1. From 1998 level to peak level, house price in Los Angeles metro area increased the most, 199.6 percent, or from 1 to 2.996, while in Cleveland 23.7 percent, the least. From the peak level to the bottom in spring 2009, house prices declined the most in Las Vegas metro area, 58 percent, the least in Dallas metro area, 4 percent.

House prices in the metro areas did not peak and bottom at the same time either, the Cleveland and Detroit metro areas are the first to see their house prices peaked in June 2005, about a year earlier than the national index, apparently because of an exogenous shock, the automobile industry were laying off more employees as it had been losing ground in international competition. House prices peaked last in the Charlotte metro area in August 2007, more than a year later than the national index. After several years of sharp declines, house prices in the Dallas, Denver and Washington Arlington metro areas started to move up in January 2009, and finally the Las Vegas metro area in October 2009.

Most of the metro areas that have the highest house prices remain in the upper 10 range in the whole sample period, i.e., San Francisco, San Diego, Boston, New York and Washington DC, with Los Angeles' order fluctuating the most. Over half of the upper ten high-price metro areas at the peak around summer 2006 are among the ten areas that suffered the largest percentage price declines in the following 3 years. Eight of the upper 10 areas where house prices increased the most are among the 10 areas that suffered the most price declines.

Table 1. Descriptive Statistics

	Price Changes		
	1998 - Peak	Peak - Bottom	
Mean	1.065	-0.272	
Std. Dev.	0.569	0.143	
Minimum	0.237	-0.578	
Metro area	(Cleveland)	(Las Vegas)	
Maximum	1.996	-0.042	
Metro area	(Los Angeles)	(Dallas)	
Los Angeles	1.996	Las Vegas	-0.578
Miami	1.854	Phoenix	-0.457
San Diego	1.768	Miami	-0.433
San Francisco	1.692	Detroit	-0.423
Washington	1.631	San Francisco	-0.390
Tampa	1.464	San Diego	-0.375
New York	1.368	Tampa	-0.364
Las Vegas	1.332	Los Angeles	-0.363
Phoenix	1.330	Washington	-0.278
Seattle	1.090	Minneapolis	-0.242
Boston	1.030	Atlanta	-0.205
Portland	0.901	Cleveland	-0.196
Minneapolis	0.844	Chicago	-0.192
Chicago	0.717	Seattle	-0.188
Denver	0.527	Boston	-0.182
Atlanta	0.433	Portland	-0.169
Charlotte	0.402	New York	-0.147
Dallas	0.377	Denver	-0.134
Detroit	0.300	Charlotte	-0.076
Cleveland	0.237	Dallas	-0.042
Median House Price to Per Capita Income Ratio			
	1998	2006	2009
Mean	5.019	7.590	5.073
Std. Dev.	1.350	3.202	1.713
Minimum	3.307	3.627	2.707
Metro area	(Tampa)	(Cleveland)	(Cleveland)
Maximum	8.607	14.426	8.223
Metro area	(San Francisco)	(Los Angeles)	(San Francisco)

The median house price to per capita income (P/I) ratio also rose and declined dramatically from 1998 to 2009 because house prices rose much faster than incomes since 1995 (Case and Shiller, 2003), and dropped much faster than income. From 1998 to 2006 the P/I ratio of Los Angeles metro area was more than doubled, that of San Diego area was close to be doubled, and only two of the twenty metro areas' P/I ratios were lower than their

1998 levels. At the bottom of house prices in 2009, 12 of the 20 metro areas' P/I ratios were lower than that of 1998, although the price bottom is at about the 2003 level. (The price bottom in January 2012 is around April 2002 level). As shown in table 1, the average of the twenty metro areas' P/I ratios increased from 5.02 in 1998 to 7.59 in 2006, and then declined to 5.07 in 2009. The 2009 level of the average ratio is lower than the average of 1989-1998, 5.37. This supports the opinion (Case and Shiller, 2003, HMS, 2005, Zhou, 2010) that home prices would stay in line with the fundamentals in the long run.

Metro areas with the highest P/I ratios in 1998 are still in the top range in 2006 although the orders changed slightly for all the areas except San Diego, stayed at the second in both years, similar ranks stayed in 2009. House prices declined the most during the crash in seven out of the top ten areas that have higher P/I ratios.

Factors related to the dramatic price movements and to P/I ratio

Two characteristics or variables appear to be closely related to the significantly different levels of P/I ratios, as well as to the magnitudes of house price movements of the metro areas, they are income growth and population density.

As mentioned above, it is generally agreed that income growth contributes to house price increase. Meanwhile, house price movements may affect income (Miller, Peng and Sklarz, 2011), as increasing house prices promote new construction, which creates new jobs and add to income growth. Also, as CHM (2004) have summarized, house prices should rise as population increases.

We use equations (1) and (2) to reveal the relationship between the metro areas' income growth, population density and growth, and the degree of their house price inflation during 1998 and 2006, and their 2006 P/I ratio.

$$Pu_j = \alpha + \beta_1 D_j + \beta_2 Gp_j + \beta_3 Gi_j \quad (1)$$

$$P/I_j = \alpha + \beta_1 D_j + \beta_2 Gp_j + \beta_3 Gi_j \quad (2)$$

Where,

Pu_j = percentage increase in house price index in area j from 1998 to peak

P/I_j = median house price to per capita income ratio of area j in 2006

D_j = relative population density in area j

Gp_j = population growth in area j from 1998 to 2006

Gi_j = per capita income growth in area j from 1998 to 2006

j = 1, … , 20

Relative population density is calculated as each metro area's density divided by the average density of the twenty metro areas, i.e., if the average density is 1,000 people per square mile, an area's density is 1,200 people per square mile, then the area's relative density is 1.2. The regression results are reported in Table 2.

Table 2. Increase in House Prices, 2006 P/I, and Related Factors

Price Increase	*Intercept*	*Relative Density*	*Population Growth*	*Income Growth*	Adjusted *R* square
Coefficient	-0.322	0.140	-0.063	4.060	0.582
T-Statistics	(-1.194)	(1.276)	(-0.309)	(4.402)***	
2006 P/I Ratio					
Coefficient	-0.081	1.149	-0.934	21.815	0.581
T-Statistics	(-0.054)	(1.863)*	(-0.819)	(4.203)***	

Notes: Price Increase and 2006 P/I ratio are the dependent variables.

* Significant at the 10% level.

*** Significant at the 1% level.

Coefficients for the variable population density are positive, which implies a positive relationship between population density and price increase, and price level. Areas that experienced the most house price increase are those with the highest population density, such as Los Angeles, Miami, and San Francisco metro areas. Areas with the highest P/I ratios are the most populated. And, areas with the highest house price levels are also the most populated, such as Boston, Los Angeles, New York, San Francisco and Washington DC.

Coefficient for income growth rate is positive and statistically significant in both Equations (1) and (2), which indicates strong positive relationships between income growth and house price inflation and the 2006 P/I ratio. Metro areas that have the largest house price increases also have the highest income growth. The causation can be in both directions as discussed above. This result is consistent with the report by Miller, Peng and Sklarz (2011). Certainly, higher population density and stronger income growth bring larger demand for house to the market.

In the model with 2006 P/I ratio being the dependent variable, the relationship is significantly positive to both population density and income growth, or the higher the density and income growth the more the price increase, because of the same reasons discussed above. From 1998 to 2006, house prices have risen more than five times faster than income growth, which supports the findings by Case and Shiller (2003) and Wheaton and Nechayev (2008).

The coefficient for population growth is negative in both equations. The signs are obviously wrong and the statistics are insignificant. Wrong signs of coefficients on fundamental factors occur often in regression analysis (PWS 1991, Meen 2002, Gallin 2006, Wheaton and Nechayev 2008, Zhou, 2010).

Next, we investigate the characteristics or factors that are related to the sharp price declines from the peak to the bottom in 2009, particularly whether areas with the highest P/I ratios in 2006 and the lowest population density suffered the largest price declines. The relationships are estimated by the model as shown in equation (3):

$$Pd_j = \text{Ln } P/I_j + \text{Ln } D_j + \text{Ln } I_j \qquad (3)$$

Where,
Pd_j = percentage decline in house price index of area j from peak to bottom in 2009
Ln = natural logarithm
P/I_j = median house price to per capita income ratio of area j in 2006
D_j = relative population density in area j
I_j = relative per capita income in area j
j = 1, … , 20

Relative income is calculated as a metro area's per capita income divided by the twenty metro areas' average per capita income, i.e., if the average is $40,000, an area's per capita income is $44,000, then the area's relative income level is 1.1.

The results are reported in Table 3. The sharp decline in house prices from the peak to the bottom in 2009 is significantly negatively related to the 2006 P/I ratio, i.e., the higher the ratio at the peak, the greater the price decline through the bottom in 2009.

The price crash is positively related to population density, or the higher the density, the less the price decline, because, ceteris paribus, high density helps to keep relatively larger demand and hence prevents large proportional sales (number of units for sale as a proportion to total existing units). Metro areas where house prices plunge the most during the price crash are the least populated ones, Las Vegas and Phoenix.

Table 3. Decline in House Prices and Related Factors

Price Decline	Intercept	Ln P/I Ratio	LnRelative Density	LnRelative Income	Adjusted *R* square
Coefficient	0.213	-0.241	0.046	0.347	0.348
T-Statistics	(1.458)	(-3.293)***	(1.472)	(1.538)	

Notes: Price decline is the dependent variable.
Ln represents natural logarithm.
* Significant at the 1% level.

The price crash is positively related to relative income level in the metro area, or the higher the income level the less price decline, because the higher the income level in an area, ceteris paribus, proportionally the less short sales and foreclosures that depress prices much heavier than regular and speculative sales.

Warning level estimate

There is no method for estimating a warning level of house price bubble in the existing literature yet. Finding some warning level of an indicator should help investors and governments to avoid a bubble or reduce the severity of the consequences of a bubble. Based on the above analyses, we establish a formula that may help to estimate the warning level of a house price bubble after several years of rapid price increases, but sufficiently before prices rise too high and burst.

The attempt to predict the warning level of house prices above which a bubble is to burst has been unsuccessful. In this study we try to estimate above what level of the price to income ratio house prices are too high, not sustainable, and going to crash. An advantage of using P/I ratio for estimating warning level over using house prices is that it is much less volatile than prices. The 20 metro areas' average of the ratio declined from 5.78 in 1989 to 4.95 in 1997, up slightly to 5.05 in 1998, peaked in early 2006, and then declined to 5.07 in 2009. The 2009 level is slightly higher than the 1998 level but moderately lower than the 1989-1998 10-year average of 5.37.

Also, the ratio is generally used as an affordability measurement. Using P/I ratio allows us to estimate the upper limit of aggregate demand for housing at the time, as the ratio rises too much above the warning level, ceteris paribus, demand in the market will soon be insufficient to support the existing price level for long, hence a bubble is growing, and its bust is looming.

Apparently, using P/I ratio for this purpose faces a big challenge, the P/I ratios are quite diverse among areas although much less diverse then price levels. For example, the ratio is 14.43 in the Los Angeles metro area while 3.63 in the Cleveland metro area as of 2006, the difference is almost four times. The ratio is the highest for the San Francisco metro area in both 1998, and 2009, 8.6 and 8.2, respectively. The ratio is the lowest for the Cleveland metro area in both 2006 and 2009, 3.63, 2.71, respectively.

The formula we build for estimating P/I warning level is shown as equation (4):

$$wP/I = bP/I + \ln(1+D)+\ln(1+Gi)+\ln(1+Gp)+\ln(1+S)+\ln(1+E) \quad (4)$$

where,
wP/I = warning level P/I ratio
bP/I = base P/I = average P/I ratio of the base period
D = relative population density
Gi = income growth in the period, 1998 - 2003
Gp = population growth in the period, 1998 - 2003
S = personal saving rate
E = exogenous shock

The ten-year average price to income ratio is used as the base P/I ratio, the ten years before the rapid price inflation, 1989-1998, is the base period. Choosing ten years for the base is a little arbitrary, one may argue for

fifteen or thirty years. We believe the ten years' data is sufficient for the average as it reflects the base condition of the U.S. house market, and the market was normal in the 10-year period.

Population density and income growth are important known factors as discussed earlier, population growth should have positive impact on house prices (CHM, 2004). We also need to include personal saving rate, because personal saving rate represents part of the ability to invest in real estate, pay down payment, and hence demand for houses. The American people's saving rate is 5.3% in 1998, and 3.5 for both 2002 and 2003. There is no personal saving rate data for metropolitan areas. However, it is well known that Orientals have much higher saving rates, which may imply higher saving rates in the Los Angeles and San Francisco metro areas where there are large oriental populations.

The extremely low saving rate of the American people should not support rapid house price increases, however, it was made up by the easy mortgage loans and loose down payment requirements in the bubble period. It is well recognized that easy credit and loose down payment requirements inflated the U.S. house price bubble (Wheaton and Nechayev 2008, and Mian and Sufi 2008) as they add to the ability to purchase real estate or demand for houses. However, there is no applicable statistics for quantifying easy credit and loose down payment requirement and for incorporating the factors into the warning estimate equation yet.

An exogenous shock may also move house prices. For example, a significant increase in foreign purchases of houses in an area, a large employer settling down in an area would push prices in the area up, and vast lay off by major employers in an area would depress house prices. An international example of exogenous shock occurred in 1997, the Asian financial crisis started in Thailand punctured the house price bubble in Hong Kong, where home prices dropped 46 percent in one and half years. But there is no applicable statistics for quantifying or measuring the impact of exogenous shock yet. Fortunately for the U.S. house price bubble, we may set E = 0 because the economy was normal during the formation of the bubble, and until one and half years after the bust of the bubble. The short, moderate recession in 2001 did not wither the bubble, only reduced growth rate of prices for several months.

It is common sense that speculation is often responsible for large price movements but it is extremely difficult to build such common sense in a quantitative model. Now one may have noticed that the equation does not require any forecast of the factors.

Take the twenty metro areas as a whole, from 2000 to 2003, the warning P/I level increased from 6.28 to 6.39, while the actual P/I ratio increased from 5.28 to 6.58. The actual level has been below the warning level until 2003. Hence, the alarm is triggered in 2003, after four years of rapid house price inflation. In practice, governments and investors may monitor the P/I ratios of major areas on an annual or semiannual base. The estimated warning levels of 2003 and the actual P/I levels of 2003, 2006, 2009 and 1998 are listed in Table 4.

The estimates could provide effective warning for most of the metro areas, and even better for the average of all the metro areas. Assuming that the 20 metropolitan areas' house markets together can represent the nation's house market, the estimated P/I warning level could leave 18.78 percent room and more than two years of time for action, as the average warning level is 18.78 percent below the average actual level of 2006 P/I ratio. Meanwhile, the average of the actual P/I ratios increased 15.3 percent from 2003 to 2006, the increase is smaller than the 18.78 percent because the average of the actual P/I ratios in 2003 rose above the warning level. Fortunately, the average of the estimated warning levels that may function as a national warning level is even better than the warning level for individual areas because economic policies for avoiding house price bubble should be conducted nationwide and only nationwide policies are feasible in free market economies.

Table 4. Estimated Warning P/I Levels and Actual P/I Ratios

	2003 P/I	03Warning Level P/I	2006 P/I	2009 P/I	1998 P/I
Atlanta	4.65	4.79	4.71	3.33	3.71
Boston	8.27	7.68	7.96	6.21	6.23
Charlotte	4.54	5.85	4.96	4.97	4.75
Chicago	6.14	6.25	6.57	4.49	4.76
Cleveland	4.32	5.03	3.63	2.71	4.23
Dallas	4.06	5.24	3.75	3.36	3.57
Denver	6.07	5.13	5.54	4.72	4.57
Detroit	4.46	4.83	4.07	2.85	4.47
Las Vegas	5.77	6.14	8.29	3.89	4.87
Los Angeles	10.65	9.95	14.43	7.80	7.06
Miami	7.07	6.72	9.01	4.94	4.81
Minneapolis	5.14	4.66	5.24	3.88	3.79
New York	8.45	7.35	9.28	7.30	5.10
Phoenix	5.15	5.10	7.70	3.98	4.54
Portland	5.91	5.56	7.06	5.71	5.28
San Diego	11.93	9.08	14.09	7.87	7.46
San Francisco	11.96	11.35	13.01	8.22	8.61
Seattle	6.22	6.13	7.84	6.08	4.63
Tampa	4.55	4.59	6.45	3.74	3.31
Washington	6.33	6.43	8.21	5.42	4.63
Natioanl	**6.58**	**6.39**	**7.59**	**5.07**	**5.02**
Actual 2006 P/I to Warning level = 7.59/6.39 - 1 = 18.78%					

As of 2003 when the alarm is triggered, an actual P/I level in an area that is higher than the warning level indicates the danger of bubble in the area, an actual P/I level lower than the warning level may not. Areas that suffered the largest price declines, namely, Los Angeles, Miami, Phoenix, and San Francisco, saw their P/I ratios rose above the warning level in 2003, Boston, New York and San Diego did in 2002, but the warning missed Las Vegas in 2003. The P/I ratios of different metro areas did not rose above the warning level simultaneously because, as discussed earlier, the magnitudes and timing of price increases are diverse.

The estimated warning level for several metro areas is not useful as they are much higher than the areas' 2006 levels, which is of no surprise. For Cleveland and Detroit, an obvious reason is the exclusion of the negative exogenous shock from the automobile industry. Including the negative shock in the equation should make the warning levels much lower. Unfortunately, we do not have an explanation for the unusefulness of the other three area's warning levels. Quite several studies, including Wei and Shiller (1991), Abraham and Hedershott (1996), Lamont and Stein (1999), Capozza et al. (2002), HMS (2006), Wheaton and Nechayev (2008) and Zhou (2010) have explored the relationship between home prices and fundamentals across geographic areas and conclude that the relationships are diverse. History has shown that human has not been able to avoid a price bubble yet. In October 1996, Chairman of the Federal Reserve Alan Greenspan warned of the "irrational exuberance" in the U.S. stock market, the bubble burst almost three and half years later and ended in early October 2002 at the level lower than that of October 1996. From late 2004 Greenspan mentioned 3 times about possible house price bubble, the bubble burst more than one and half years later. The Fed did not take any action to control the

bubble, maybe because the Fed was not sure about the existence of the bubble as no one could be, and also believed that "investors can reduce risk through diversification" as Greenspan changed his tone about house price bubble in September 2005. We hope this study will be proved to have made a small step forward toward avoiding house price bubble or reducing the severity of the consequences of price bubble in the future.

Conclusion

Income growth and population density are positively related to the degree of rapid house price inflation between 1998 and 2006 and to the peak level of price to income ratio. Based on the analysis of the movements and levels of house prices, P/I ratios, and the fundamental factors, we establish an equation that can be used to estimate warning level of price to income ratio. The method does not require forecast of any factor so that the estimate involves less uncertainty. The estimated warning could leave 18.78 percent room and more than two years of time for actions. We wish this method can help governments and investors to avoid house price bubble or reduce the severity of the consequences of a bubble. For this U.S. case, the twenty metro areas' average P/I ratio rose above its warning level after four years of rapid house price inflation, the four-year long period may not be the same for other developed countries. And, emerging economies may take shorter than four years because their house prices are more volatile. We use the average P/I ratio of the ten years before the rapid run-up in house prices as the base ratio for the United States, one may use much less years for emerging economies as prices and incomes increase much faster and are much more volatile there.

Policy decisions should not be made only based on an econometric model as models are subject to creative destruction. One strong market force, speculation, is not included in our equation as it is beyond our ability at least for now, in addition to other possible unknown factors.

Raising down payment rate may be a feasible way to discourage speculative demand for houses, to reduce the speed of house price inflation and hence to abate the risk of a price bubble. A government may raise down payment requirement for speculators as the nation's P/I ratio rises above the warning level, but not for first home buyers and occupiers. A government may also raise capital requirement for real estate loans to curb aggressive speculation by lending institutions. Although a government may not be able to fight the market forces, it may at least help to keep the financial system less vulnerable.

Further research is expected to compare the house price bubbles in different countries, investigate the factors that contribute to the speed and magnitude of price inflation and the level of P/I ratio, such as personal saving rate and population density, and to explore unknown factors that are responsible for house price bubble. Specifically, areas with very high personal saving rates, such as China, Hong Kong, and Japan also have very high P/I ratios. We also need to estimate by how much a nation's P/I ratio rises above the warning level before the bubble is likely to burst, in this U.S. case, it is 18.8 percent, then based on current pace of price growth we may estimate the time of the bubble's burst, if there is no government intervention. And of course, our equation for estimating warning level should be tested for countries currently experiencing rapid house price increases.

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